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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
SECTION B—PHYSICS.

AT the summer meeting of the American Association for the Advancement of Science, held in Ithaca, N. Y., from June 28 to July 3, 1906, Section B met in joint sessions with the American Physical Society. The section was, in an especial sense, the guest of the department of physics of Cornell University, for on this occasion there occurred the formal dedication of the new Rockefeller Hall of Physics. At the dedication exercises there were addresses by President Schurman, Professor E. L. Nichols, Dr. Elihu Thomson, Professor W. H. Welch and by Professor W. A. Anthony (read by Professor Merritt, in Professor Anthony's absence). After the addresses, the magnificent laboratory was opened for inspection.

On account of the interest in the new laboratory, no doubt, the attendance at the regular sessions was large, there being about seventy present. The president of the American Physical Society being absent, the vice-president of Section B, Professor W. C. Sabine, presided at all the sessions. A very interesting joint program of twenty-seven papers was presented. Abstracts and titles are given below. Besides the features already mentioned, several receptions and excursions, and the general hospitality of Cornell University added greatly to the enjoyment of the meetings. This summer meeting was very successful.

A New Type of Young's Modulus and Hooke's Law Apparatus: B. B. BRACKETT, Clarkson School of Technology.

This apparatus has a horizontal bed or base of wood, about 1.8 m. long, 20 cm. wide and 5 cm. thick. At one end is a clamp elevated 6 cm. to hold the wire tested, and at the other end is a rather large disk pulley over which the wire is drawn, while weights attached to the vertical portion of the wire beyond the pulley supply the desired tensions.

To compensate for the springing of the light and not very rigid base, an easily rolling platform is placed upon the base, between it and the wire. One end of this platform is held by a spring in firm contact with the clamp just at the point where it grips the wire, but the platform is entirely free from the wire at all other points.

A micrometer microscope is placed on the end of the platform next to the pulley to read the elongations of the wire. This arrangement keeps the microscope at the same distance from the fixed end of the wire, however much the plank base may be warped or shortened by the tensions placed on the wire.

The apparatus is of very simple construction, is easily used, quickly adjusted and gives results of the most satisfactory kind.

A Convenient Lecture Room Resistance for Electrical Experiments: B. B. BRACKETT, Clarkson School of Technology.

The resistance is to be used for controlling the current from a dynamo circuit. Usually a tap is made from the lighting mains.

Twelve incandescent lamps are arranged within a partially open box, 70 cm. long and 25 cm. square. Single pole, double throw switches are connected to the lamps so that all possible parallel, series and combination groupings are readily obtained.

While open enough for ventilation and to make the switches easily accessible, the containing box protects both lamps and switches from all the usual accidents to such apparatus, and enables one to use it in any place or position, on either end or on any side.

All the connecting wires are plainly visible and this, with the regular arrangement of the switches, shows at a glance what grouping of the lamps is being used. Hence there is little probability of making a mistake. Short circuits can not be made by any position of the switches.

Two Neglected Factors in the Determination of Musical Quality: W. C. SABINE, Harvard University.

The musical quality of a sound in an ordinary room or other confined space is very greatly affected by the character of the walls. Diagrams are presented showing the effects of various wall surfaces and substances. The other factor is the sensitiveness of the ear to sounds of different pitch and a diagram is presented showing the relative intensity for equal loudness under ordinary musical conditions.

Silver Perchlorate as the Electrolyte for the Silver Coulometer: HENRY S. CARHART, H. H. WILLARD and W. D. HENDERSON, University of Michigan.

A New Alternating-current Galvanometer: L. A. FREUDENBERGER, Lehigh University.

A Lecture Experiment in Electrolytic Thermo-Electromotive Force: HENRY S. CARHART, University of Michigan.

Note on the Graphical Representation of Non-Sinusoidal Alternating Currents: FREDERICK BEDELL, Cornell University.

Spark Potentials in Liquid Dielectrics: ROBERT F. EARHART, Ohio State University.

Measurements on the potential required

to cause a spark to pass between a ball and plate were made, with kerosene, olive oil, paraffin oil and a transformer oil as the intervening dielectrics.

Distances of separation vary from .003 to .118 mm. and were measured in terms of wave-lengths of sodium light.

A plane surface was attached to the movable carriage of an interferometer. This was brought in contact with a ball mounted on the interferometer base. These were separated and the fringes crossing the interferometer field noted. From this data distances of separation of the surfaces were computed.

P.D.'s were obtained from an A.C. transformer and were measured with a Weston voltmeter.

The data secured are compared with similar measurements made by the author when air was used as a dielectric.

Spark potential-distance curves for the various oils used give curves similar in form to those for air.

These experiments on the limited number of oils used indicate:

1. A higher potential gradient for small than for large distances.

2. That for small distances air is a better insulator than a liquid dielectric.

3. That the potential at which the bend in the potential-distance curve occurs is the same for air and the liquids operated upon.

The Dispersion of Silver Chloride: E. F. NICHOLS and W. S. DAY, Columbia University.

Properties of Electric Charges on Moving Conductors: E. F. NICHOLS, Columbia University.

The Separation of Electric Charges in a Metal by Centrifugal Acceleration: E. F. NICHOLS, Columbia University.

Comparative Observations on the Evolution of Gas from the Cathode with the Glow Current in Helium and Argon: CLARENCE A. SKINNER, University of Nebraska.

The Effect of Absorbed Hydrogen on the Photoelectric Current: W. F. HOLMAN, University of Nebraska.

Light from a spark arc between iron terminals in hydrogen was directed through a quartz optical system on to a zinc disk, serving as cathode—a disk of aluminum opposite serving as anode—the electrodes being in a highly evacuated chamber. Under these conditions the rate of leak of negative electricity from the zinc was represented by 32 scale divisions of the measuring instrument.

The zinc was then partially relieved of its supply of hydrogen by use as cathode with the glow discharge in hydrogen, after which it was again tested as before for its photoelectric current, which was found to be now represented by only about 22 scale divisions. This test was followed by using the zinc as anode with the glow discharge in hydrogen, the object of which process was to store up in it a new supply of hydrogen. A test of the photoelectric current as before showed that it had returned to its first value, giving, namely, a deflection of about 32 scale divisions.

The Production of Ozone by Becquerel Rays: HARRY S. HOWER, Case School of Applied Science.

The Production of Ozone by the Photoelectric Current in Oxygen: HARRY S. HOWER, Case School of Applied Science.

Fluorescence Absorption in Resorufin: FRANCES WICKE, Cornell University.

Further Experiments on the Phosphorescence of Sidot Blende: E. L. NICHOLS and ERNEST MERRITT, Cornell University.

Magnetograph Records of Earthquakes with Special Reference to the San Francisco Earthquake of April 18, 1906: L. A. Bauer, Magnetic Survey, Washington.

Rotation and Elliptic Polarization produced by Iron Films in a Magnetic Field: W. D. Harris, University of Nebraska.

Films were obtained on microscope cover glass by cathode deposit *in vacuo.* The rotation of the plane of polarization was measured by use of a Lippich half-shade Nicol prism, and the ellipticity of the light by means of a Brace half-shade elliptic polarizer and compensator. Films deposited in hydrogen exhibited a rotation rising gradually from zero in the violet to a maximum value in the red. The same films showed an ellipticity of the transmitted ray increasing from a zero value in the violet to a maximum at about 600 $\mu\mu$, then a gradually decreasing value toward the red end of the spectrum. With age the values for the longer wave-lengths dropped to a marked extent. A film of same density deposited in nitrogen produced a smaller rotation as well as smaller ellipticity, the latter possessing a maximum value at about 560 $\mu\mu$. A film deposited in oxygen gave no rotation for any wave-length, but a slight ellipticity, this being a maximum at about 540 $\mu\mu$ and dropping rapidly to zero in passing toward either end of the spectrum. All films showed marked polarity when suspended in a magnetic field.

The film deposited in hydrogen tested for variation in ellipticity with the strength of field showed this to be proportional to the field up to about 8,000 C.G.S. units, after which there was but a small increase as the field was intensified.

The reflected light exhibited in no case any observable ellipticity, although three per cent. of that observed in case of transmitted light would have been readily detected.

Cobalt and nickel films deposited in hydrogen showed a rotation similar to iron, but no ellipticity.

Coefficient of Linear Expansion at Low Temperatures: H. G. Dorsey, Cornell University.

New Diffraction Spirals: A. G. Webster, Clark University.

The Calibration of Capillary Tubes: Willard J. Fischer, Cornell University.

The Latent Heat of Recalescence in Iron and Steel: Frank H. Bailey, Clark University.

Thermal and Electrical Effects in Soft Iron between 100° and 218°: Edwin H. Hall, Harvard University.

This will give the results of a continuation of the study which my colleagues and I have already published, in the *Proceedings* of the American Academy for May, 1906. The general method followed has been the same as before and the results obtained are in general accord with those which we have before obtained at a lower temperature.

Note on Certain Aspects of Drude's Electronic Theory of Metallic Conduction: Edwin H. Hall, Harvard University.

I wish to raise the question whether the expansion of metals is to be accounted for by the expansive force of the imprisoned electrons and what effect these electrons should have on the specific heat of metals.

The Capacity and Resistance of Aluminum Anode Films: C. McC. Gordon, Central University of Kentucky.

Films were formed on aluminum anodes with a direct current of known voltage and their capacity measured in the Wheatstone bridge with a small alternating current.

As was reported in a previous paper, the

capacity was found to be practically independent of the electrolyte so long as water solutions are dealt with. Since, *cet. par.*, the capacity decreases proportionally to the thickness of the film, for the sulphuric-acid films to have a capacity as large as the films formed in other solutions seemed to be contradictory to the observation of others who had investigated the question of the thickness of the films; the sulphuric-acid films always having been found to be much thicker than those in other solutions.

Further experiments by the writer have confirmed the results as to the greater thickness of the sulphuric-acid film, as well as the fact that they do not have any smaller capacity than the others. With water-cooled tubular electrodes sulphuric-acid films more than 0.3 mm. thick were formed; but their minimum capacity values were slightly larger than those of other films whose maximum thickness could not have been more than 0.001 mm. Sodium sulphate gives films similar to those in sulphuric acid as to both thickness and capacity.

These results necessitate the conclusion that with the sulphates *the insulating film is not the whole film;* but that we have, superimposed on the insulating film, whose capacity is measurable, a conducting film many times thicker. For solutions other than the sulphates there is no evidence for any such dual-natured film.

The resistance of these films as measured by the Wheatstone bridge with small alternating current is much smaller than the apparent resistance as calculated from the residual direct current.

Bridge measurements were taken both while the direct current was still acting and after it was turned off, while the switching on or off of the direct current made no change in the capacity, the resistance of the films was only about one third as large with the current on as with it off.

Spark Potentials between a Point and Plane, for Small Distances: ROBERT F. EARHART, Ohio State University.

Measurements were made on the P.D. required to cause a spark to pass between a needle point and plane surface. The P.D.'s were secured from an A.C. transformer and were measured with a Weston voltmeter. No. 10 Sharp needles were used as the point electrode. A large number of needles were examined with a microscope and points approximating a pattern needle were chosen.

Distances separating the electrodes were measured with an interferometer.

Curves representing the relation between spark-potential and distance are similar to those showing the same relation between a spherical electrode and a plane.

For air, at atmospheric pressure the so-called 'minimum potential' was found to lie between 290 and 310 volts.

This value does not agree with results secured by other observers from static machines. The value given by Tamm is 2,150 volts when the point is negative and 3,300 for a positive point.

DAYTON C. MILLER,
Secretary of Section B.

THE SCIENTIFIC INVESTIGATION OF THE PSYCHICAL FACULTIES OR PROCESSES IN THE HIGHER ANIMALS.[1]

FOR a consistent investigator there is in the higher animals only one thing to be considered—namely, the response of the animal to external impressions. This response may be extremely complicated in comparison with the reaction of animals of a lower class. Strictly speaking, natural science is under an obligation to determine

[1] The Huxley lecture on recent advances in science and their bearing on medicine and surgery. Delivered by Professor Ivan P. Pavlov at Charing Cross Hospital on October 1, 1906. From the report in the *British Medical Journal.*

only the precise connection which exists between the given natural phenomenon and the responsive faculty of the living organism with respect to this phenomenon—or, in other words, to ascertain completely how the given living object maintains itself in constant relation with its environment. The question is simply whether this law is now applicable to the examination of the higher functions of the higher quadrupeds. I and my colleagues in the laboratory began this work some years ago, and we have recently devoted ourselves to it almost completely. All our experiments were made on dogs. The only response of the animals to external impressions was a physiologically unimportant process—namely, the excretion of saliva. The experimenter always used perfectly normal animals, the meaning of this expression being that the animals were not subjected to any abnormal influence during the experiments. By means of a systematic procedure easy of manipulation it was possible to obtain an exact observation of the work of the salivary glands at any desired time.

It is already well known that there is always a flow of saliva in the dog when something to eat is given to it or when anything is forcibly introduced into its mouth. In these circumstances the escaping saliva varies both in quality and quantity very closely in accordance with the nature of the substances thus brought into the dog's mouth. Here we have before us a well-known physiological process—namely, reflex action. It is the response of the animal to external influences, a response which is accomplished by the aid of the nervous system. The force exerted from without is transformed into a nervous impression, which is transmitted by a circuitous route from the peripheral extremity of the centripetal nerve through the centripetal nerve, the central nervous system, and the centrifugal nerve, ultimately arriving at the particular organ concerned and exciting its activity. This response is specific and permanent. Its specificity is a manifestation of a close and peculiar action of the external phenomena to physiological action, and is founded on the specific sensibility of the peripheral nerve-endings in the given nervous chain. These specific reflex actions are constant under normal vital conditions, or, to speak more properly, during the absence of abnormal vital conditions.

The responses of the salivary glands to external influences are, however, not exhausted by the above-mentioned ordinary reflex actions. We all know that the salivary glands begin to secrete, not only when the stimulus of appropriate substances is impressed on the interior surface of the mouth, but that they also often begin to secrete when other receptive surfaces, including the eye and the ear, are similarly stimulated. The actions last mentioned are, however, generally considered apart from physiology and receive the name of psychical stimuli. We will take another course, and will endeavor to restore to physiology what properly belongs to it. These exceptional manifestations unquestionably have much in common with ordinary reflex action. Every time that there is a flow of saliva attributable to this cause, the occurrence of some special stimulus among the external influences may be recognized. On very careful exercise of his attention, the observer perceives that the number of spontaneous flows of saliva forms a rapidly diminishing series, and it is in the highest degree probable that those extremely infrequent flows of saliva for which no particular cause is at first sight apparent are in reality the result of some stimulus invisible to the eye of the observer. From this it follows that the centripetal paths are always stimulated primarily and the centrifugal paths secondarily, of course, with the interposition of the central nervous system.

In the first place, they arise from all the bodily surfaces which are sensitive to stimulation, even from such regions as the eye and the ear, from which an ordinary reflex action affecting the salivary glands is never known to proceed.

It must be observed that ordinary salivary reflexes may originate not only from the cavity of the mouth, but also from the skin and the nasal cavity. In the second place, a conspicuous feature of these reflexes is that they are in the highest degree inconstant. All stimuli introduced into the mouth of the dog unfailingly give a positive result in reference to the secretion of saliva, but the same objects when presented to the eye, the ear, etc., may be sometimes efficient and sometimes not. In consequence of the last-mentioned fact, we have provisionally called the new reflexes 'conditioned reflexes,' and for the sake of distinction we have called the old ones 'unconditioned.' Every conditioned stimulus becomes totally ineffective on repetition, the explanation being that the reflex action ceases. The shorter the interval between the separate repetitions of the conditioned reflex the more quickly is this reflex obliterated. The obliteration of one conditioned reflex does not affect the operation of the others. Spontaneous restoration of the obliterated conditioned reflexes does not occur until after the lapse of one, two or more hours, but there is a way in which our reflex may be restored immediately. All that is necessary is to obtain a repetition of the unconditioned reflex—as, for instance, by pouring vinegar into the dog's mouth and then either showing it to him or letting him smell it. The action of the last-mentioned stimuli, which was previously quite obliterated, is now restored in its full extent. If for a somewhat long time—such as days or weeks continuously—a certain kind of food is shown to the animal without being given to him to eat, it loses its power of imparting a stimulus from a distance—that is, its power of acting on the eye, the nose, etc.

We may, therefore, say that the conditioned reflex is in some way dependent on the unconditioned reflex. At the same time we see also the mechanism which is necessary for the production of our conditioned reflex. When an object is placed in the mouth, some of its properties exercise an action on the simple reflex apparatus of the salivary glands, and for the production of our conditioned reflex that action must synchronize with the action of other properties of the same object when the last-mentioned action, after influencing other superficial parts of the body that are sensitive to such stimuli, arrives in other parts of the central nervous system. Just as the stimulant effects due to certain properties of an object placed in the mouth may be associated as regards time with a number of stimuli arising from other objects, so all these manifold stimuli may by frequent repetition be turned into conditioned stimuli for the salivary glands. It must be remembered that in feeding a dog or forcing something into its mouth each separate movement and each variation of a movement may by itself represent a conditioned stimulus. If that is the case, and if our hypothesis as to the origin of the conditioned reflex is correct, it follows that any natural phenomenon chosen at will may, if required, be converted into a conditioned stimulus. Any ocular stimulus, any desired sound, any odor that might be selected, and the stimulation of any portion of the skin, either by mechanical means or by the application of heat or cold, have in our hands never failed to stimulate the salivary glands, although they were all of them at one time supposed to be ineffective for such a purpose. This was accomplished by applying these stimuli simultaneously with the action of the salivary glands, this action having been evoked by

the giving of certain kinds of food, or by forcing certain substances into the dog's mouth. These artificial conditioned reflexes, the product of our training, showed exactly the same properties as the natural conditioned reflexes previously described. As regards their obliteration and restoration, they followed essentially the same laws as the natural conditioned reflexes.

Up to the present time the stimuli with which we had to do were comparatively few in number, but were constant in action. Now, however, in another more complicated portion of the nervous system we encounter a new phenomenon—namely, the conditioned reflex. On the one hand, the nervous apparatus is responsive in the highest degree—that is, it is susceptible to the most varied external stimuli, but, on the other hand, these stimuli are not constant in their operation and are not uniformly associated with a definite physiological effect. The introduction of the idea of conditioned reflexes into physiology seems to me to be justified because it corresponds to the facts that have been adduced, since it represents a direct inference from them. It is in agreement with the general mechanical hypotheses of natural science. It is completely covered by the ideas of paths and inhibition, ideas which have been sufficiently worked up in the physiological material of the present day. Finally, in these conditioned stimuli, looked at from the point of view of general biology, there is nothing but a very complete mechanism of accommodation or, which amounts to the same thing, a very delicate apparatus for maintaining the natural equilibrium. There are reasons for considering the process of the conditioned reflex to be an elementary process—namely, a process which really consists in the coincidence of any one of the innumerable vague external stimuli with a stimulated condition of any point in a certain portion of the central nervous system. In this way for the time being a path is made by which the stimulus may reach the given point.

Although there are differences in the time required for the establishing of the conditioned reflexes, some proportionality may be perceived. From our experiments it is very evident that the intensity of the stimulation is of essential importance. In contradistinction to this we must state with regard to acoustic impressions that very powerful stimuli, such as the violent ringing of a bell, were not, in comparison with weaker stimuli, quick to produce conditioned increase of function in the salivary glands. It must be supposed that powerful acoustic stimuli produce in the body some other important reaction which hinders the development of the salivary reaction.

What is it that the nervous system of the dog recognizes as individual phenomena of external origin? or, in other words, what are the elements of a stimulus? If the application of cold to a definite area of the skin acts as a conditioned stimulus of the salivary glands, the application of cold to another portion of the skin causes secretion of saliva on the very first occasion. This shows that the stimulus of cold generalizes itself over a considerable portion of the skin, or perhaps even over the whole of it.

Stimulation by musical sounds or by noise in general is remarkably convenient for determining the discriminating or analytical faculty of the nervous system of the dog. In this respect the precision of our reaction goes a great way. If a certain note of an instrument is employed as a conditioned stimulus, it often happens that not only all the notes adjoining it, but even those differing from it by a quarter of a tone, fail to produce any effect. Musical *timbre* is recognized with similar or even much greater precision.

We have hitherto spoken of the analytical

faculty of the nervous system as it presents itself to us in, so to say, the finished condition. We have now accumulated material which contains evidence of a continuous and great increase of this faculty if the experimenter perseveres in subdividing and varying the conditioned stimulus, and thereby makes it coincide with the unconditioned stimulus. Here, again, is a new field of enormous extent. In this material relative to the conditioned stimuli there are not a few cases in which an evident connection between the effect and the intensity of a stimulus can be seen. As soon as a temperature of 50° C. had begun to induce a flow of saliva it was found that even a temperature of 30° C. had a similar effect but in a much less degree. Trial was then made of combinations consisting of stimuli of the same kind and also of stimuli of different kinds. The simplest example is a combination of different musical notes, such as a harmonic chord, which consists of three notes. When this is employed as a conditioned stimulus each two notes together and each separate note of the chord produce an effect, but the notes played two and two together accomplish less than the whole, and the notes played separately accomplish less than those played in pairs. The case becomes more complicated when we employ as a conditioned stimulus a combination of stimuli of different kinds, that is, of stimuli acting upon different kinds of susceptible surfaces. Only a few of such combinations have been provisionally experimented with. In these cases for the most part one of the stimuli was a conditioned stimulus. In a combination in which rubbing and cold were employed the former was preponderant as a conditioned stimulus while the application of cold taken by itself produces a hardly perceptible effect. But if an attempt is made to convert the weaker stimulus separately into a conditioned stimulus it soon becomes an energetic conditioned stimulus. If we now apply the two stimuli together we have before us an evident case of them acting in combination. The following problem had for its object to explain what happens to an active-conditioned stimulus when a new stimulus is added to it. In the cases that were examined, the action of the preexisting conditioned stimulus was hindered when a new stimulus of a like kind was added to it. A new odor of a like kind hindered the operation of another odor which was already acting as a conditioned stimulus; a new musical note similarly hindered the operation of the note previously employed which was a conditioned stimulus. After a conditioned stimulus had been applied, together with another one which inhibited its action, the action of the first one alone was greatly weakened and sometimes even stopped altogether. This is either an after-effect of the inhibiting stimulus which was added or it is the obliteration of the conditioned reflex, because in the experiment of the added stimulus the conditioned reflex is not strengthened by the unconditioned reflex. The inhibition of the conditioned reflex is also observed in the converse case. When you have a combination of stimuli acting as a conditioned stimulus—in which, as has been already stated, one of the stimuli by itself produces almost no effect—frequent repetition of the powerful stimulus by itself without the other one leads to a powerful inhibition of its action, even to the extent of its action being almost destroyed. The relative magnitudes of all these manifestations of stimulation and inhibition have a very close connection with their dependence on the conditions under which they originate.

Experiments have been made in the production of conditioned reflexes by traces or latent remnants both of a conditioned and of an unconditioned stimulus. The method was that a conditioned

stimulus was either allowed to act for one minute immediately in advance of an unconditioned stimulus or it was even applied two minutes earlier. Conversely, also, the conditioned stimulus was not brought into action until the unconditioned reflex was at an end. In all these cases the conditioned reflex developed itself; but in the cases in which the conditioned stimulus was applied three minutes before the unconditioned one, and was separated from the latter by an interval of two minutes, we obtained a condition which was quite unexpected and extremely peculiar, but was always repeated. When scratching was applied to a particular spot—for instance, as a conditioned stimulus—after it began to produce an effect it was found that scratching of any other place also produced an effect, just as in the case of cold or heat applied to the skin, new musical sounds, optical stimuli and odors. The unusually copious secretion of saliva, and the extremely expressive movements of the animal attracted our attention. It may appear that this manifestation is of a different kind from those with which we have hitherto been occupied. The fact was that in the earlier experiments at least one coincidence of the conditioned stimulus with the unconditioned one was necessary, but on the present occasion manifestations which had never occurred simultaneously with an unconditioned reflex were acting as conditioned stimuli. Here an unquestionable point of difference naturally comes to light, but at the same time there is also to be seen another essential property of these manifestations which they have in common with the former ones—that is, the existence of a very sensitive point in the central nervous system, and in consequence of its position this point becomes the destination of all the important stimuli coming from the external world to make impressions on the receptive cells of the higher regions of the brain.

Three characteristic features of this subject make a deep impression upon him who works at it. In the first place, these manifestations present great facilities for exact investigation. I am here referring to the ease with which they may be repeated, to their character of uniformity under similar conditions of environment, and to the fact that they are capable of further subdivision experimentally. In the second place, it is inevitable that opinions formed on this subject must be objective only. In the third place, the subject involves an unusual abundance of questions. To what departments of physiology does it correspond? It corresponds partly to what was in former days the physiology of the organs of special sense and partly to the physiology of the central nervous system.

Up to the present time the physiology of the eye, the ear and other superficial organs which are of importance as recipients of impressions has been regarded almost exclusively in its subjective aspect; this presented some advantages, but at the same time, of course, limited the range of inquiry. In the investigation of the conditioned stimuli in the higher animals, this limitation is got rid of and a number of important questions in this field of research can be at once examined with the aid of all the immense resources which experiments on animals place in the hand of the physiologist. The investigation of the conditioned reflexes is of very great importance for the physiology of the higher parts of the central nervous system. Hitherto this department of physiology has throughout most of its extent availed itself of ideas not its own, ideas borrowed from psychology, but now there is a possibility of its being liberated from such evil influences. The conditioned reflexes lead us to the consideration of the position of animals in nature; this is a sub-

ject of immense extent and one that must be treated objectively.

Broadly regarded, physiology and medicine are inseparable. Since the medical man's object is to remedy the various ills to which the human body is liable, every fresh discovery in physiology will sooner or later be serviceable to him in the preservation and repair of that wonderful structure. It is an extreme satisfaction to me that in honoring the memory of a great physiologist and man of science I am able to make use of ideas and facts which from a unique standpoint affording every prospect of success throw light upon the highest and most complicated portion of the animal mechanism.

SCIENTIFIC BOOKS.

Lehrbuch der Anorganischen Chemie. Von Professor Dr. H. ERDMANN, Direktor des anorganisch-chemischen Instituts der königlichen technischen Hochschule zu Berlin. Vierte Auflage (neuntes bis zwölftes Tausend) mit 303 Abbildungen, 95 Tabellen, einer Rechentafel, und sieben färbigen Tafeln. Braunschweig, F. Vieweg und Sohn. 1906. Pp. 796. In Leinwand gebunden M. 17.

A long review of the second edition of this book appeared in SCIENCE in 1901.[1] The present edition has been thoroughly revised, and contains valuable additions to text, to illustrations and to tables.

The weaknesses and the strong points of the book remain practically the same, as both are inherent in the author's scheme. Erdmann believes that a text-book of inorganic chemistry should describe the occurrence, properties, reactions, manufacture and uses of all inorganic elements and compounds, with liberal illustration of instructive experiments, of apparatus and of technical processes. No other one-volume text-book is so complete, so well illustrated and so thoroughly up to date in these respects.

Erdmann does not believe in the introduction of physical chemical theory in the descriptive text, but makes a brief résumé of general chemistry in the 87 pages of the introductory chapter. There are those who will sympathize with Erdmann in this arrangement, others who may be reminded of the eccentric American author who left his book unpunctuated and put several pages of commas, periods, etc., at the end of the book for use as the reader might please. Certainly many phenomena in the field of inorganic chemistry find the clearest explanation by the application of the laws of physical chemistry, and remain obscure if such explanation is not given.

This objection, however, does not lessen the practical value of Erdmann's book, because there is no text-book of inorganic chemistry written from a physical chemical point of view which is comparable with Erdmann even in general descriptive data, still less in technical information. It is, therefore, to be expected that this fourth edition will meet the same cordial reception and large sales as its predecessors.

E. R.

Vermehrung und Sexualität bei den Pflanzen. Von E. KÜSTER. Leipzig, B. G. Teubner. 1906. Pp. vi + 120. 38 figures.

In America one is accustomed to look with suspicion upon all books in which an attempt is made to popularize science. All too often this suspicion is justified, for who has not met with books in which scientific accuracy has been sacrificed to the sensationalism demanded by a certain class of the public or where the science is so diluted by allegory or fable as to be unrecognizable. The book before us is, however, of an entirely different type. It is one of a series of popular scientific works ('Aus Natur und Geisteswelt') in which each book is written by a specialist who knows his subject.

The subject of reproduction and sexuality in plants is a difficult one to handle so as to be comprehended by persons who have studied but little or no botany and it is in this connection that the chief criticism can be made, to the effect that it is to be feared that parts of the book will be found too technical to be

[1] SCIENCE, Vol. XIII., pp. 268–70.

understood by such persons, at least with readiness.

Eighteen pages are devoted to vegetative reproduction with a discussion of cuttings, runners, bulbs, tubers, grafting, etc., in the higher plants, and of conidia, swarm-spores and fission in the fungi and algæ. Eighty-seven pages treat of sexual reproduction. The author traces the history of the knowledge of sexuality in plants from the Greek philosophers down to its demonstration by Camerarius, confirmation by Kohlreuter, discovery of the pollen-tube by Amici, observation of sexuality in cryptogams by Hofmeister, Thuret and Pringsheim, and the more recent investigations showing the part played by the nuclei, chromosomes, synapsis, etc., thus bringing the subject down to this year. After this historical and general discussion the different groups of plants are taken up, showing the increasing complexity of the sexual process from the union of two equal cells up to the complicated processes in the higher fungi and algæ, the alternation of generation and development of heterospory in the Archegoniatæ and the double fertilization in the Angiosperms. Under the caption General Questions are taken up sexual affinity, hybrids, polyspermy, parthenogenesis, parthenocarpy, apogamy, apospory, merogony and determination of sex. The final considerations take up the theory of fertilization and the theory of sex, the various views being presented in an unbiased manner as well as the objections to them.

Although professedly designed for those who are not specialists this book should prove valuable for both students and teachers. The references to literature, both old and very recent, although with no pretence to completeness, yet give the most important contributions bearing on the subject. The figures are, for the most part, very good.

Ernst A. Bessey.

SOCIETIES AND ACADEMIES.

THE AMERICAN PHILOSOPHICAL SOCIETY.

A stated meeting was held on Friday evening, November 2, 1906, at 8 o'clock. The following papers were read:

Dr. Alfred C. Haddon, F.R.S., University Lecturer in Ethnology, Cambridge, Eng.: 'The Decorative Art of British New Guinea.' (Illustrated.)

Dr. John W. Harshberger: 'A Grass-killing Slime Mould.'

DISCUSSION AND CORRESPONDENCE.

SOME POINTS IN TEACHING CRYSTALLOGRAPHY.

The writer wishes to call attention to and invite discussion of the following points in the teaching of crystallography as a part of the work in elementary mineralogy.

The best classification even for beginning students is that of the thirty-two crystal classes, based upon symmetry. All ideas of hemihedrism should be dropped as there is no structural connection between the whole and partial forms. The name of the class is the name of the general form. Groth's set of names is the best, but his names for the isometric classes may be replaced by the terms, tetartoidal, gyroidal, diploidal, hextetrahedral and hexoctahedral for classes twenty-eight to thirty-two.

A division of crystals into seven systems is preferable to that of six. Crystals with an axis of three-fold symmetry naturally form one system and those with an axis of six-fold symmetry another system. And this is true whether the three axes of Miller or the four axes of Bravais are used. The writer prefers to treat the orthorhombic system, one of moderate symmetry, first.

It is believed that von Fedorow's method of naming forms (adopted by Groth in his 'Physikalische Kristallographie') is the only logical one. The name of a form depends upon its shape and is independent of how it cuts the axes of reference. A pinacoid consists of two parallel faces whether its symbol is 100, *h0l*, *hkl* or what not. A pyramid is three or more like faces meeting in a point and a bipyramid is two such solids placed base to base. Instead of using a name for the particular form, *e. g.*, pinacoid of the first kind, as von Fedorow does, we may simply give the name of the form together with the symbol, *e. g.*, pinacoid (100).

There is weighty argument in using the Miller symbols even with beginners in crystallography. In elementary work only type symbols are used and for these the Miller system is as easy as any. One only has to replace one index of the symbol *hkl* by a zero when a face is parallel to an axis. When it comes to a question of actual symbols the Miller indices of course take precedence over the Weiss. If one learns Miller from the start there is never the necessity of translating back and forth from Weiss, which is a waste of energy. And lastly the Miller is the only universal system.

The fact that the axial ratios are irrational and that the indices are rational is a thing that always gives many students trouble. Thus most students can not see why the symbol 111 does not represent a face that cuts the three axes *a, b* and *c* at equal lengths. The writer has used a homely illustration that usually makes it clearer at least. Take two cities, laid out in different ways. A pedestrian on inquiring about a certain building in either place might be told: Go two blocks north, three blocks east. Yet the actual distance he had to walk in the two cities would be different, for the lengths of the blocks are different. These distances are on record and correspond to the axial ratios. Yet the pedestrian is not concerned directly with them. The two blocks and three blocks correspond to the indices.

In order to really understand some of the essential points of crystallography the student must devote some time to crystal measurement, calculation and drawing. And without something of the sort, the time given to crystallography may almost be a waste of time unless it is taken up at some future time. To accomplish this in the limited time available in a general course in mineralogy is difficult. The writer has had partial success with the following method. Selected crystals or wooden models preferably orthorhombic with 110, *hk*0, 011 and one or more of 100, 010 or 001 are chosen.

(1) Free-hand sketch of the crystal.

(2) Number faces and indicate zones.

(3) Measurement of interfacial angles with the contact goniometer.

(4) Stereographic projection on sheets devised by Penfield.

(5) Graphic determination of *a* and *c* from 110 and 011.

(6) Graphic determination of indices *hk*0.

(7) Orthographic projection (plan and elevation) from stereographic.

Taken up in this manner the work is not at all difficult for the drawing of zone circles is not necessary in the stereographic projection and the tedious clinographic projection is replaced by the orthographic. Yet the student appreciates something of the meaning of axial ratios and indices and is ready, if need be, to take up more advanced work.

AUSTIN F. ROGERS.
STANFORD UNIVERSITY, CAL.

SPECIAL ARTICLES.

IS THERE DETERMINATE VARIATION?

HOWEVER willingly we incorporate in our general conception and knowledge of variation the special conception of mutations (in the de Vriesian sense) and however implicitly we accept de Vries's primrose species by mutation, we must none the less hold clearly in mind that the kind of variation still most familiar to us all is that kind variously called individual, fluctuating, continuous or Darwinian variation, and we must not for a moment, because some species may have been shown to have arisen in some other way, deem ourselves absolved from the responsibility of further testing the Darwinian assumption of species-forming by the natural selection of individuals possessing advantageous slight variations.

If new species arise by virtue of a cumulation or progressive increase of small fluctuating variations in continuous series, they can apparently only do so through (*a*) natural selection, or (*b*) determinate or orthogenetic variation. The principal argument for a belief in determinate variation so far advanced seems to be that natural selection is unable to make use of fluctuating variation because (1) this variation is too small and useless to be a handle for life and death selectivity, and be-

cause (2) of the swamping or extinguishing of favorable variations by their intermating with unfavorable or neutral conditions.

Thus there is necessary some influence tending to cumulate variation independent of, or antecedent to, selection. This influence or causal factor in species-forming on a basis of continuous variation must, therefore, be something whose result is determinate or orthogenetic variation. What can produce such progressive variation doesn't for the moment seem very obvious. But a prior consideration for observation and experiment (pedigreed breeding) may well be that of the determination of whether we can actually distinguish the occurrence of the determinate variation. If we can't discover its existence we need not trouble our fevered wits with questions of how it might be produced.

I wish, therefore, to present some facts[1] concerning a little green and black beetle that infests our Californian flower gardens—one *Diabrotica soror* or 'California flower beetle' by name—that seem to me to have intimate relation to the problem just stated.

This beetle has its black and green colors arranged on its back (dorsal surfaces of the wing-covers) in the form of twelve distinct black blotches or spots on a green ground, six spots in three transverse pairs (or two longitudinal rows) on each wing-cover. At least the original description of this species gives this patterning, and systematic accounts and revisions of the genus have always ascribed to the species *soror* twelve separate black blotches on a green (or yellow-green) ground. In Horn's revision of the genus in 1893 (*Trans. Amer. Ent. Soc.*, V. 20, p. 89 ff.) the fact of a tendency of the black spots to coalesce is fleetingly referred to. But undoubtedly the twelve-free-spots type is the pattern which is accepted as the typical and usual one.

In its larval stage this beetle lives as a slender white grub underground, feeding on the roots of alfalfa, chrysanthemum and various other plants. It pupates in a small subterranean cell near the surface and the adult beetle, on issuance from the pupal cuticle, makes its way aboveground and feeds on the buds and opened flowers of roses, chrysanthemums and almost any other of California's favorite blossoms. The color pattern of the adult is, of course (as the insect is one of 'complete metamorphosis') definitive and fixed as to both pattern and color at the time of the first appearance of the adult aboveground.

By the aid of several industrious assistants I have been able to collect from the same locality in the same months each year a thousand or more specimens of *Diabrotica soror* in each of five separate years included in the last decade. In addition, we have made other collections from other localities in California of series varying from a few score to a thousand individuals. With the help of these same indefatigable[2] helpers all of these thousands of beetles have been closely scrutinized and honestly described with regard to the actual condition of their elytral pattern. The results of this work are graphically represented in the accompanying 'frequency polygons' and statistical tabulations.

From this scrutiny and compilation it is apparent, (1) that in this patterning variations of the strictly fluctuating or continuous sort exist, as was to be expected; (2) that this variation is strongly marked and hence readily tabulatable, which is fortunate for our study; (3) that this variation does not follow Quetelet's law of error, in which characteristic it departs from the usual condition of fluctuating variation, but is not unique; (4) that this variation plainly sets strongly in a certain specific direction, that is, tends strongly toward the production of one particular new type of pattern rather than toward dissipating itself by futile equal attempts in various and thus mutually extinguishing directions; and (5) that this tendency is on the steady increase in our own times, under our very eyes.

The pattern variation is shown (by selecting certain principal types appreciably distinct)

[1] See Kellogg and Bell, 'Studies of Variation in Insects,' *Proc. Wash. Acad. Sci.*, Vol. 6, pp. 203–332, 1904, for a detailed account of the variation in *Diabrotica soror*.

[2] Instructor R. G. Bell and students R. Patterson and B. E. Wiltz.

in Fig. 1, where *A* represents the condition accepted by the systematists as typical of the species (both right and left elytra are shown); *B* shows the two spots of the middle transverse pair of the left wing-cover fused; *C*, the corresponding two spots of the right wing-cover fused; *D*, the two spots of the posterior transverse pair of the left wing-cover fused; *E*, the corresponding spots of the right wing-cover fused; *F*, the longitudinal fusing of the spots on the left wing-cover, and *G*, the corresponding condition for the right wing cover.

These different patterns are closely connected by intergrading conditions; that is, there may be (theoretically) and are (actually) all degrees of fusion of the two spots in

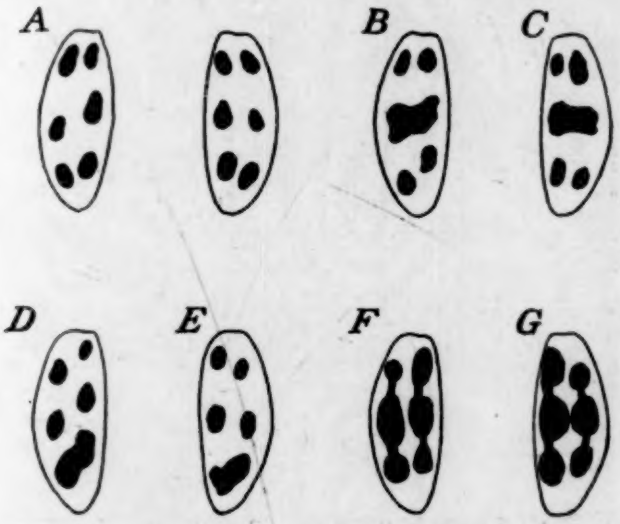

Fig. 1. Diagrammatic representation of the varying elytral color pattern of the California flower beetle, *Diabrotica soror*.

these various pairs that show fusion at all, from the slightest running together to the complete type shown by the diagrams of Fig. 1. But for the sake of aggregating individuals into describable groups any fusion is called fusion, and the existence of even the slightest space or line of green between two spots is recognized as 'no fusion' or 'free spots.' As a matter of fact, in the great majority (about five sixths) of cases of fusion the spots are well joined.

In the following tabulations and graphic representations (by frequency polygons) of the condition of the varying color pattern in the species (on the Stanford University campus) in different years, series of approximately 1,000 are used. That a series of 1,000 individuals collected from one locality at one time fairly represents, in the variation revealed by its members, the actual variation conditions of the species in this locality, as regards both kinds of variation and frequency of these kinds, is proved by repeated tests made by examining and tabulating successive

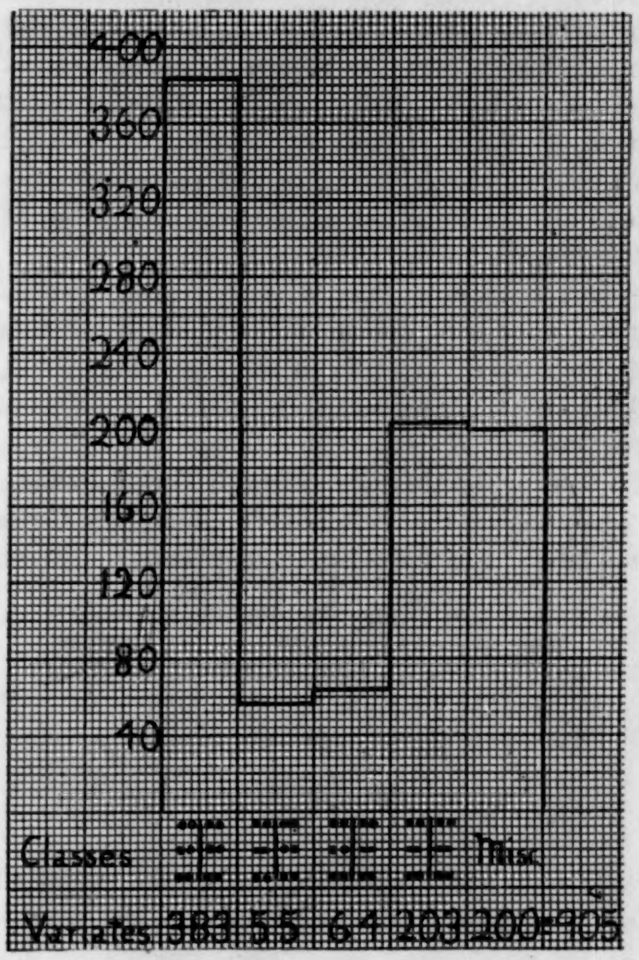

Fig. 2. Frequency polygon of the variation in elytral pattern of 905 specimens of the California flower beetle, *Diabrotica soror*, collected on the Stanford University campus, 1895.

thousands and finding a practical identity in these separate series. Indeed, series of 500 gave practically always approximately the same curve as those of 1,000. But the larger number is the safer.

Attending now to the actual variability shown by the elytral color-pattern of *Diabrotica soror* in the various series examined (in the years 1895, 1901, 1902, 1904 and 1905), we find the species in 1895 showing (Fig. 2

and caption) a marked preponderance of the twelve-spots-free condition (*A* in Fig. 1) over any other pattern type, but a much stronger proportion of a certain one of the variant types than of any other form of variant. This second modal type is the one in which the members of the middle pairs of spots are fused on both wing-covers (*B* and *C* of Fig. 1). The other important variants are middle spots fused on either right *or* left wing-cover, posterior spots fused on either or both right and left wing-covers, and various longitudinal fusings. Fig. 2 and its caption give the exact data of the arrangement of this variability. (The transverse fusing of the posterior spots and all the longitudinal fusings are grouped together as 'misc.')

But note now Figs. 3, 4, 5, 6 and 7, with their captions, giving the condition of this color-pattern variation in the years 1901, 1902, 1904 and 1905, respectively. In all these cases the variant $B + C$ or middle-spots-fused type is the predominating form. The following table shows the relative frequencies of the modal-pattern types in these successive years.

	All Spots Free.	Middle Spots Fused.
1895	42.35	22.40
1901	34.05	43.70
1902	34.05	42.80
1904	20.90	65.40
1905	35.20	46.50
1905[3]	26.87	53.92

If series of 1,000 really reveal the variation conditions of the color pattern in the species in these different years (and our check lots show that they do) it is apparent from these statistics that *Diabrotica soror,* in this particular locality has, in ten years, changed from a form in which one pattern type was the mode to one in which another is the mode. And this change has been gradual and cumulative; not made by a mutation or by discontinuous variation, *i. e.,* discontinuous evolution. The two modes or predominant types of pattern are connected to-day as they were ten years ago by all degrees of gradations; the variation, that is, is typically continuous or 'Darwinian' in type. Excluding then the mutation or discontinuous variation explanation of this species change there remain three possible explanations of the change (on the basis of current theories of species-modification); these are: (1) the change is simply ontogenetic, determined for each generation during its development by extrinsic influences; (2) the change is the result of natural selection; and (3) the change is due to determinate variation.

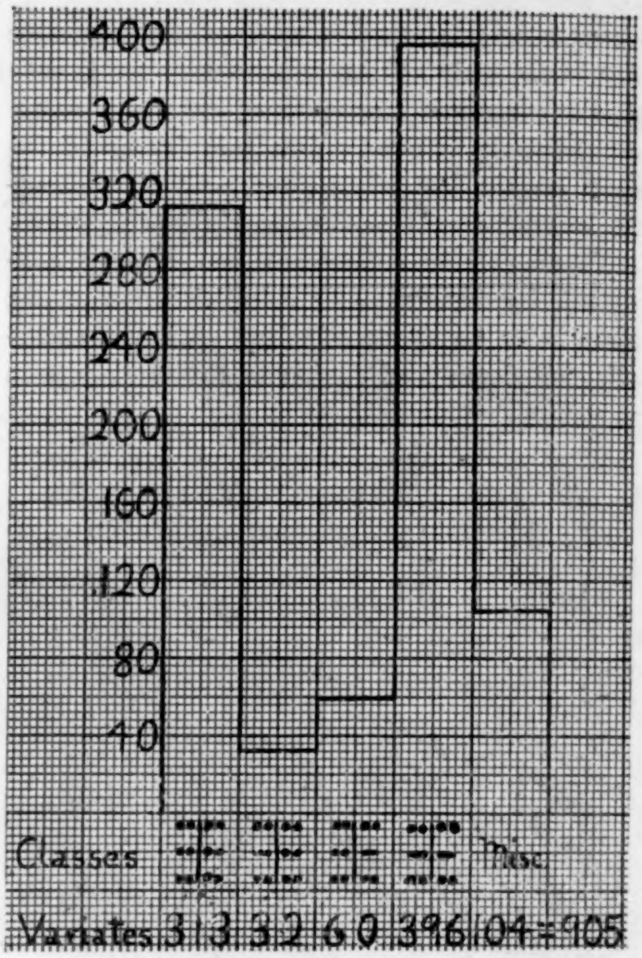

FIG. 3. Frequency polygon of the variation in elytral pattern of 905 specimens of the California flower beetle, *Diabrotica soror,* collected on the Stanford University campus, October, 1901.

The first explanation involves the assumption that the pattern is not inherited as such, but is acquired during the ontogeny of each individual as a result of environmental influence; and it further has to assume a present total environmental influence in this particular locality different from that in 1895 in the

[3] The second 1905 series was collected at a distance of several miles from the locality on the campus from which the other lots were taken.

degree and to the effect that it tends to cause an irregular transverse blotch (plainly formed by the fusion of two original separate blotches or spots) to appear in place of a transversal pair of blotches. As to the first assumption, the fact that the forming of the color pattern of the beetle requires but an hour or so, that it is carried on underground in the pupal cell, and that it is at no time exposed to above-

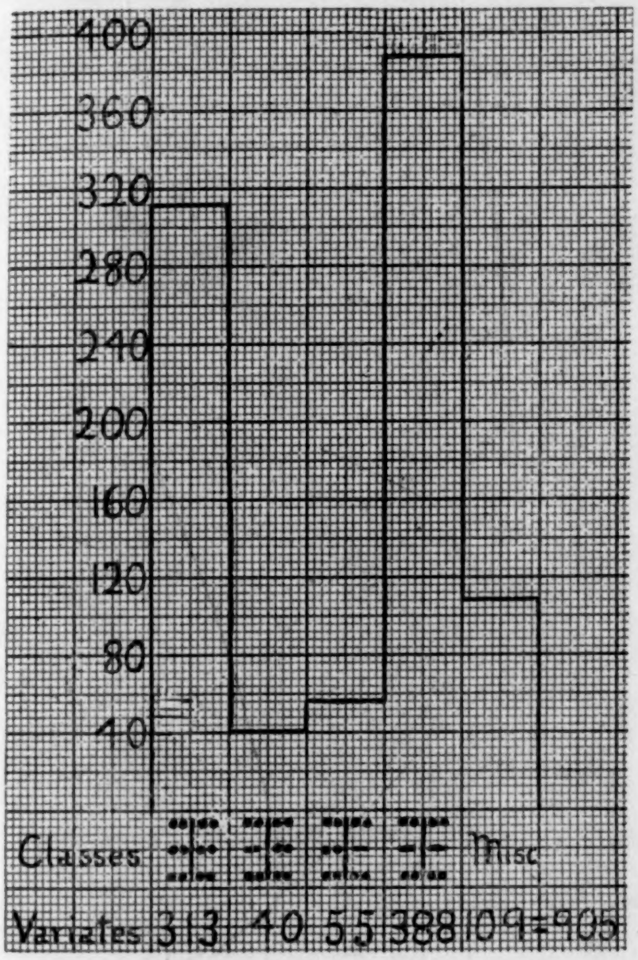

FIG. 4. Frequency polygon of the variation in elytral pattern of 905 specimens of the California flower beetle, *Diabrotica soror*, collected on the Stanford University campus, October, 1902.

ground conditions until it is in definitive unchangeable condition, and further that experiments with related species of Chrysomelid beetles (unfortunately not with this particular one) in the way of submitting the pupa and just-issued pattern-forming adult to various different conditions of light, temperature, humidity and color-surroundings, failed to produce any positive results whatever; all these facts strongly tend to invalidate the assumption of an ontogenetic determination of the color pattern. The second assumption, that of a change in environment in ten years sufficient to produce consistent ontogenetic

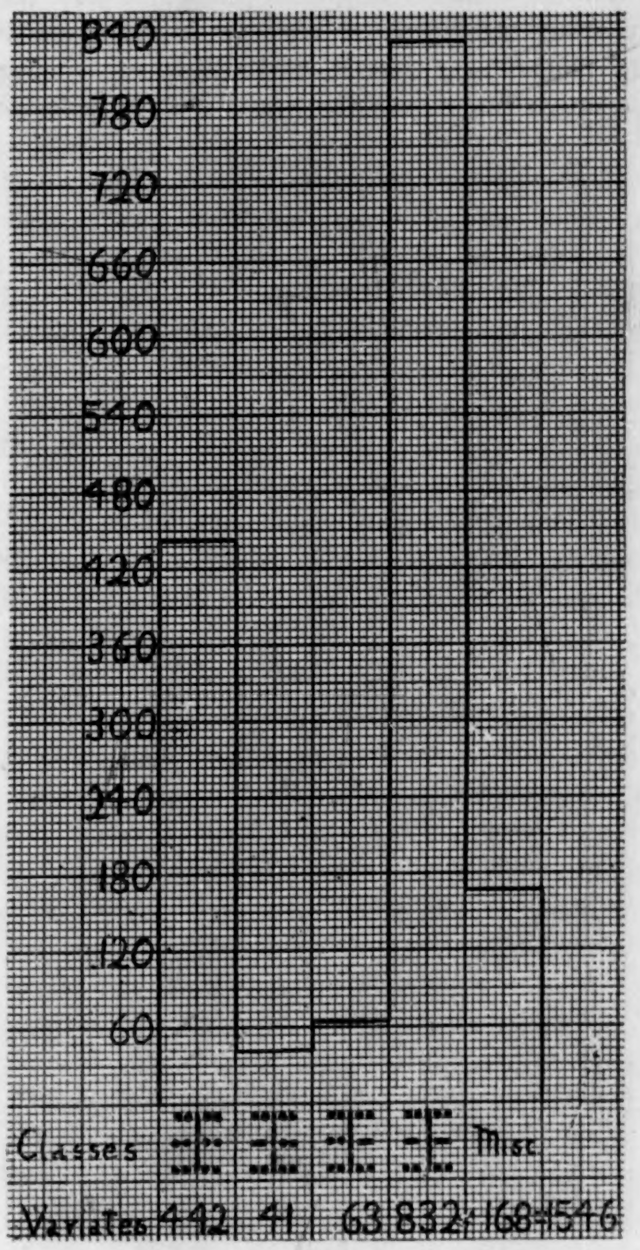

FIG. 5. Frequency polygon of the variation in elytral pattern of 1,546 specimens of the California flower beetle, *Diabrotica soror*, collected on the Stanford University campus, October, 1904.

changes in the color-pattern, certainly does violence to our knowledge, as far as it goes, of meteorological, cultural and other life-influencing conditions on our campus. No such changes are apparent.

The second explanation, that of natural

selection, based on a rigid intra-specific or individual selecting, tending to preserve the middle-spots-fused condition at the expense of the middle-spots-free condition, assumes an actual visual discrimination—let alone a presumable esthetic or preferential one—on the part of the lizards, birds and insect enemies of *Diabrotica;* that is, to be flippant, coming it much too strong for me. We really know

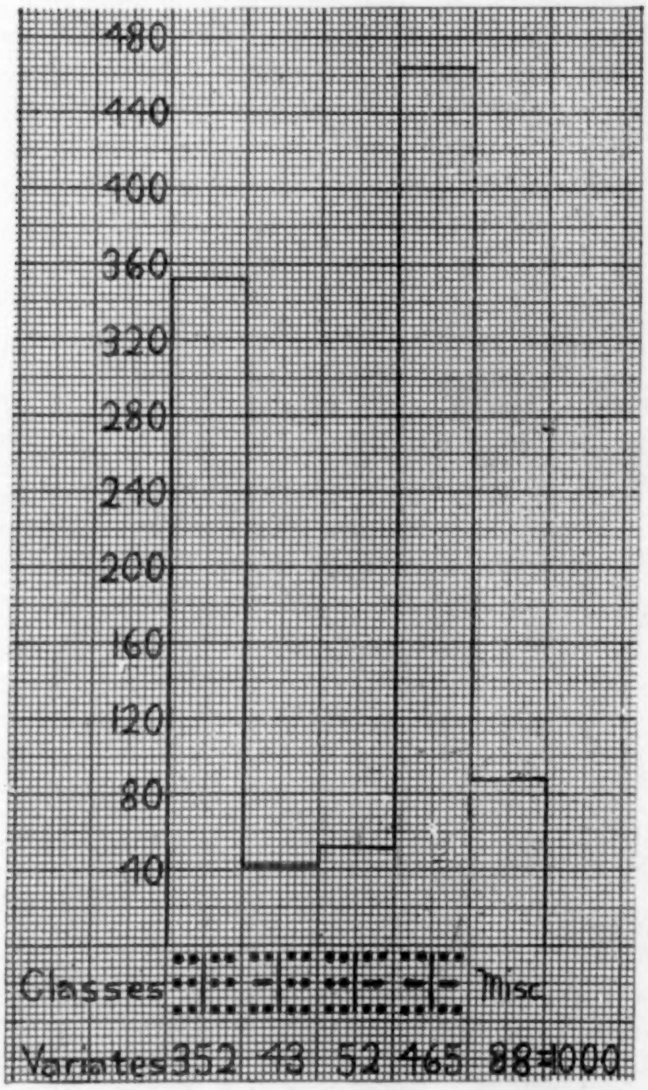

Fig. 6. Frequency polygon of the variation in elytral pattern of 1,000 specimens of the California flower beetle, *Diabrotica soror,* collected on the Stanford University campus, October, 1905.

something about the eyesight of lizards, birds and insects and it is fantastic to credit them with a capacity for distinguishing a character that in many cases requires on our part careful scrutiny with a lens to make out. When we straighten up after an hour's eye-straining work on this minute, though none the less real and from the species-student's point of view important, variation condition among our hosts of beetle specimens, we have in our minds one conviction about which there is moral certainty, and that is that no lizard,

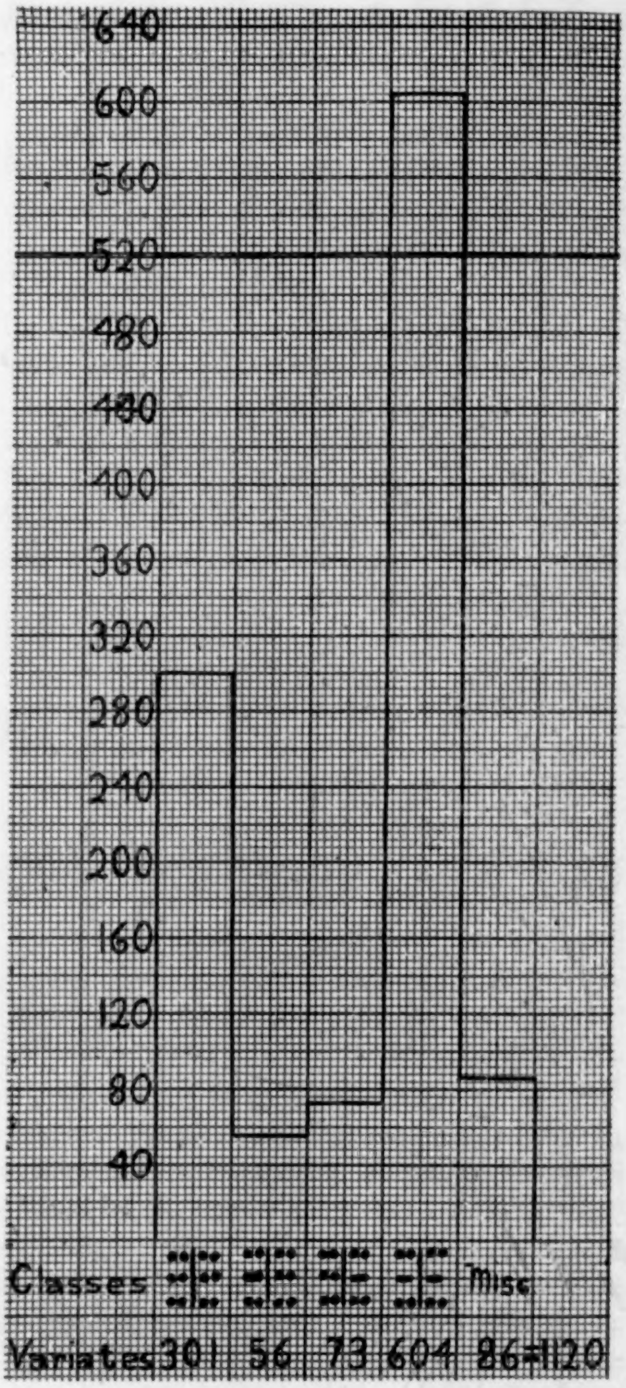

Fig. 7. Frequency polygon of the variation in elytral pattern of 1,120 specimens of the California flower beetle, *Diabrotica soror,* collected in the foothills of the Sierra Morena Mountains, about three miles from the Stanford University campus, October, 1905.

bird or insect is going to distinguish between beetle *A* and beetle *B* by the middle-spots-free or middle-spots-fused criterion. For one, I am done with meekly accepting the dictum of the selection champions who declare, in such cases as the present one, that we do not know what difference in general effect of harmony with leaf or flower or what not, and hence with the safety of the beetle, a very slight modification of pattern may produce; that we can not say of any difference, however minute, or apparently indifferent, that it is not the hair in the balance; and that when we understand *all* the conditions of the life of an or-

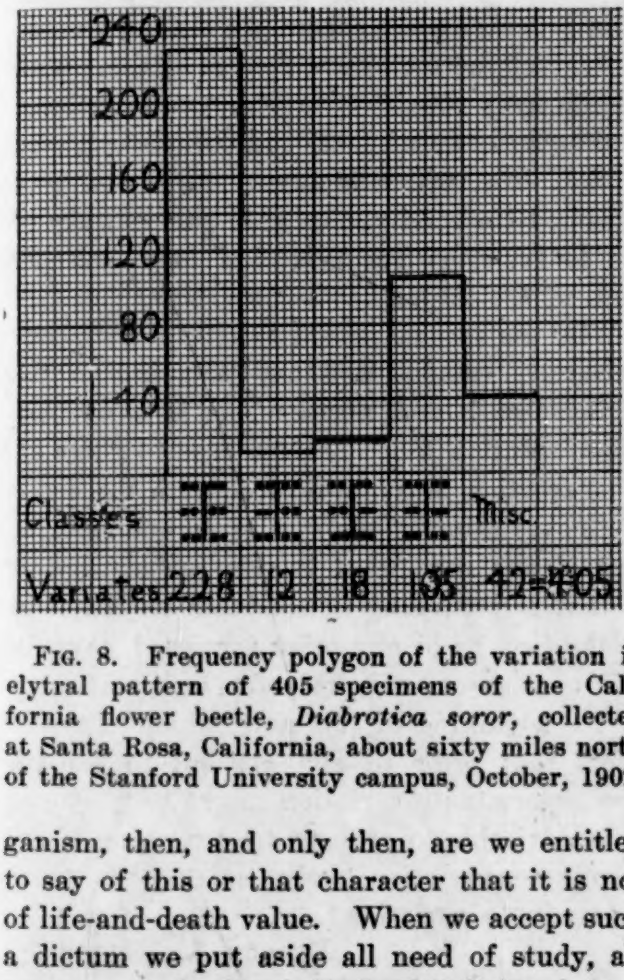

FIG. 8. Frequency polygon of the variation in elytral pattern of 405 specimens of the California flower beetle, *Diabrotica soror*, collected at Santa Rosa, California, about sixty miles north of the Stanford University campus, October, 1902.

ganism, then, and only then, are we entitled to say of this or that character that it is not of life-and-death value. When we accept such a dictum we put aside all need of study, all spur to work, for '*all* the conditions' is a phrase to crush with. However, there are but few selectionists left who insist any longer on taking this point of view. Practically all Neo-Darwinians admit the existence of hosts of trifling, insignificant, indifferent species and variety characters. As for those who still hold to their crushing dictum—well, we can simply refuse to crush.

In the particular instance before us, harmony of the color pattern of our beetle with its environment is out of the question. In fact, the glaring disharmony of the chrysomelid beetles with their habitual green leaf environment has been long notorious and has offered them a general card of admission to the group, probably not wholly fanciful, of 'aposematically' patterned animals, that is, creatures of malodor or distaste to their vertebrate enemies and conspicuously colored to warn these enemies of the malease which gastronomic attention to them will produce. So that the selective value of two-spots-fused or two-spots-free is that of helping make the pattern a distinct and readily perceived one. Now throughout the whole great family of Chrysomelid beetles the prevailing patterns are stripes, longitudinal or transverse, spots, and a clear ground color with neither spots nor stripes. In genus after genus in this family these three types of patterning are all represented by species of apparently equal abundance, vigor and general success in making life a burden to the horticulturalist and farmer. And these species with their different pattern types may, and often do, live side by side. Precisely in the genus *Diabrotica* is this interesting condition of things excellently exemplified. In the Mississippi Valley *Diabrotica longicornis*, with its unpatterned blue back, eats the sweet corn of the truck farmer, while the longitudinally black-striped *D. vittata* eats his cucumbers and melons, and the yellow *D. 12-punctata*, with its twelve separate black spots, attends to the rest of the truck. Here in California we are able to distinguish *D. soror* from *12-punctata* which ranges up to us from the middle west and great southwest only by the fact, quite sufficient for systematic coleopterologists, that the *under side* of thorax and abdomen and the bases of the legs (all parts well out of sight of preying lizard or bird) are strongly dusky instead of yellow. The exposed dorsal color pattern is the same in both. So that the differentiation of these two species was certainly never brought about by any selection of protective warning color-pattern variations.

We have also in our range a striped form, *trivittata,* hardly distinguishable from vittata.

Thus unstriped and unspotted or striped or spotted, all seem good patterns in the eyes of selection. To me, it is as clear as the

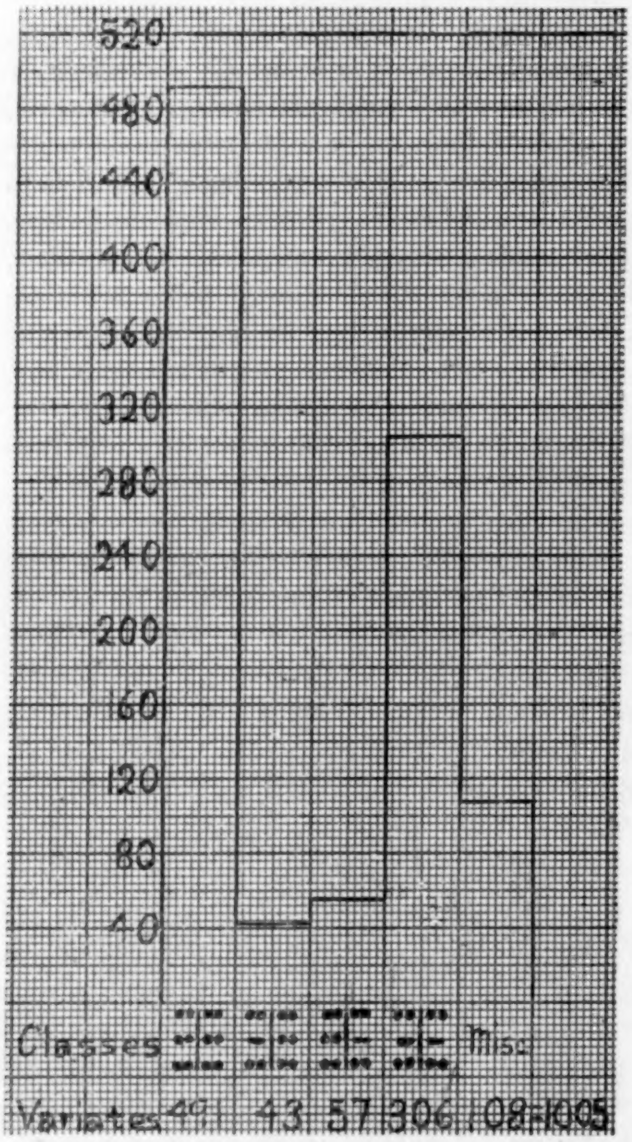

Fig. 9. Frequency polygon of the variation in elytral pattern of 1,005 specimens of the California flower beetle, *Diabrotica soror,* collected at San Jose, California, twenty miles south of the Stanford University campus, October and November, 1905.

significance of any fact in nature is clear, that the change in our locality in *Diabrotica soror* from a beetle species of typical twelve-spots-free pattern to one of eight-spots-free and two irregular transverse blotches in place of the middle four spots is not due to natural selection.

As to the third explanation, that of determinate variation, I have to say, simply, that there remains of our possible three explanations, one, which is that of determinate variation. But, we must note, if determinate variation is the explanation of this change in *Diabrotica soror* it is a determinate variation which is occurring only, apparently, in our particular locality. For in series of specimens of this bettle collected in other parts of California no such change seems to be going on, the old twelve-spots-free form being plainly the modal type. For example, in a series of 405 specimens collected in Santa Rosa, which is about sixty miles north of Stanford University, there are twice as many individuals with all spots free as of those with middle spots fused. (See Fig. 8 and caption.) And in a series of 1,005 individuals collected at San José, which is twenty miles south of Stanford University, nearly 49 per cent. are of the twelve-spots-free type and only 30.5 per cent. of the middle-spots-fused type.

Why the species should be changing on our university campus and not changing in the regions south and north of us is a mystery whose solution I do not even dare to guess at. This solution must have to do with the cause of the variation of the species on our campus. But if one asks what is this cause, what it is that is producing determinate variation in *Diabrotica,* or in any other species, I have, in this connection, only to refer to a statement in the beginning of this note, which is to the effect that prior to any attempt to explain how determinate variation might be produced it is advisable to attempt to determine if determinate variation really exists. Is there determinate variation?

Vernon L. Kellogg.
Stanford University.

DISCOVERY OF AN EARLY TYPE OF MAN IN NEBRASKA.

In a circular mound recently opened on a Loess hill north of Florence, near Omaha, Nebraska, various skeletal parts, and eight human skulls of a primitive type were exposed. The credit of the discovery belongs

to Mr. Robert F. Gilder, of Omaha, who described and figured the skulls in the *World-Herald*, October 21.

That there was intrusive burial in this mound is apparent from the fact that the skulls found below a layer of burned clay are of a much more primitive type than those found above it. Already five skulls have been taken from the lower level, and three from the upper, and others are in evidence and will be dug out later. Those of the upper layer probably belonged to Indians of a later period, and may be left out of account for the present. The skulls of the lower layer are low-browed and inferior, the superciliary ridges being thick and protruding, the distance through the temples narrow, and the frontal eminences being as feebly developed as in Neanderthal man. The low arch of the skull is not the result of head-binding, but is normal and characteristic as is evidenced by five crania, two of which are fairly complete. Unfortunately the occiput is fragmentary or wanting in the specimens now at hand.

The skulls are brachycephalic, and extremely narrow in transverse diameter through the temples, expanding rapidly at the parietals. Length of skull 182 mm.; minimum breadth 93 mm.; maximum breadth 160 mm.

In shape and size the mandible agrees well with that of modern man, although the following marked differences are to be noted; the bone, particularly in the region of the symphysis, is far heavier, the muscular scars more prominent, and the third molar in each case is ground to the very gum, while the second and third are ground in a diminishing ratio. The canines are weak and scarcely distinguishable from the incisors, and the space between the molars and the base of the coronoid is wide.

The limb bones indicate a stature of six feet, the femora being somewhat stronger, and the humeri being somewhat weaker than might be expected. The femora, which are massive, manifest an interior curvature more pronounced than ordinary, and in cross section they appear triangular through the great development of the linea aspera, all muscular scars and tuberosities are noticeably prominent, the scar for ligamentum teres being elliptical in outline, deep and nearly twice as long as broad.

The skulls of the Nebraska man seem to be inferior to those of the mound builder, but for the present at least will be viewed as early representatives of that tribe.

In corroboration are the flint implements or chips found associated with the skulls and bones, and the mode of burial. As work progresses a detailed illustrated report will be made.

E. H. Barbour,
H. B. Ward.

The University of Nebraska,
October 27, 1906.

THE SECOND DECENNIAL OF THE BOTANICAL SEMINAR OF THE UNIVERSITY OF NEBRASKA.

The botanical seminar of the University of Nebraska was organized, under the name of the 'Sem. Bot.,' as a secret society, by several advanced students in botany, on October 11, 1886. For some years it was an exclusive secret society. About 1891 it changed its policy and became a serious, scientific organization, aiming to promote research and, in particular, to organize the study of the vegetation of the state. Since that time it has admitted advanced students from time to time and has established two preliminary grades to which students are admitted after examination as a preparation for ultimate membership. It has conducted, since 1892, the botanical survey of Nebraska, has built up the survey herbarium and has published three parts of a 'Flora of Nebraska,' eight reports of the botanical survey, and the first volume of the 'Phytogeography of Nebraska.' At the same time that it has been engaged in this serious work, it has kept up the traditional secret organization, which now survives in certain traditional insignia, in the three grades of membership, and in certain traditional ceremonies.

On October 11 the seminar celebrated its second decennial. In the afternoon of that day all work in the botanical laboratories was suspended, and at three o'clock an open meeting was held which took the form of a sym-

posium on field methods, presided over by Dr. Clements.

In opening the symposium, Dr. Clements pointed out that the first decade of the organization coincided very closely with the period in which the botanical laboratory reached its greatest development. Consequently, in 1896, when the first decennial was celebrated, it was appropriate that the subject of the symposium should be 'Laboratory Methods.' During the second decade of its existence, it had fallen to the lot of the seminar not only to take part in, but also in large part to guide, the development of field work in ecology. For that reason it was especially fitting that the symposium on the occasion of the second decennial should deal with field methods.

Dr. Bessey spoke next upon 'The Place of Field Work in Botany.' He said in part:

The simplest kind of field work, and on many accounts the most productive and helpful, is that observation of plants and their environment which one makes when living much in the forests, the prairies, the swamps, the fields and the gardens. The man who lives 'in the open' and learns of plants and about plants while living with them, obtains a mass of most valuable botanical knowledge even though it may not be formulated in botanical language. Many an unlearned Thoreau knows much more about the habits of plants than the laboratory botanist who is a stranger to the wild plants in their native haunts. Then there is the more serious field—study in which with book or instrument the botanist tries to learn something accurately about plants as they grow out of doors. Here he learns something as to their classification in accordance with some general system and by means of his instruments, he learns something accurately as to the factors in the plant's environment that have controlled its growth and distribution. With such study, there usually comes the practise of collecting plants followed by the work of preserving, mounting and arranging in systematic order in the herbarium. This leads to closer and more accurate examination in the herbarium and the laboratory, and especially with the smaller kinds to critical microscopical study. Field work should underlie all botanical study. It can not be omitted without making the science one-sided. The student must do much of his work in the fields, forests and gardens if he is to make botany a science of living plants.

Dr. Barbour spoke upon 'Field Work in Geology and Physiography.' He called attention to the relation of ecological and physiographical work in the field from the point of view of the geologist and the physiographer, showing, among other things, how the result of ecological investigation has enabled the physiographer to reach better results by enabling him to trace more accurately the physiographical conditions which he studies, by reference to the resulting effects upon vegetation.

Dr. Pound spoke of the field work done in the past by the seminar. He suggested that field work as conducted by the seminar in the past fell into three stages. In the first period, from 1886 to 1892, it took the form of collection only. During that time the object was simply to collect species and to make as many additions as possible to the reported flora of the state. In the second period, from 1892 to 1898, the object of field work was floristic. During that time the foundations of phytogeographical work were laid, while the survey herbarium was built up and collecting continued. The work was chiefly directed toward determining the geographical distribution of species in the state, the working out of floral contrast between districts and regions, and regional limitation. Toward the end of that period, the method of study of abundance by the quadrat was adopted. The third period, from 1898 to the present, has been marked by research work in ecology and the development of improved research methods.

Dr. Heald spoke of field work in pathology. He said that, while formerly pathological investigation had been conducted almost wholly in the laboratory, the tendency at the present time was to go to the other extreme and to work chiefly in the field. He pointed out the necessary limitations upon each method of work in pathology and the relations of the one to the other.

In closing, Dr. Clements suggested a prophecy and a warning. As botany becomes broader and surer in its progress, the relative position of laboratory work and field work will be changed. The field will take the first place. The laboratory, though indispensable, will become secondary in that its chief use

will be to assist the interpretation of field facts and field experiments. For many reasons, this shifting of emphasis must be slow. Field methods must be developed and refined and students must be trained in their use. Field work demands instruments, base stations and much experience not for months but through years. In short, with these things, the field will become the real laboratory which must always be supplemented by secondary laboratories of histology, by plant houses, and the like. Each generation of botanical students is apt to feel that the beginnings of botany do not much antedate the beginning of its study of the subject. It sees and reads and does the things that are most recent and rarely dips into the past. It loses sight of the fact that development is of necessity a slow process and that most of the ideas and methods of to-day have a history. Hence, while the new generation is instructed to search diligently in the field and laboratory, it must not ignore the records of the past to be found in the books.

Following the open meeting, a regular meeting was held at five o'clock at which fifteen undergraduate students, who had been duly examined, were initiated in the preliminary degree of 'candidatus,' and four graduate students were promoted to the intermediate degree of 'novitius.' Thereafter, at six-thirty, a collation was spread in one of the laboratories to which a number of guests, members of the faculty of the university, had been invited. At the speaking after the collation, Dr. Pound presided. The speakers were Dr. Bessey, Dr. E. W. Davis, dean of the College of Arts, Dr. H. K. Wolfe, professor of educational psychology, and Dr. Bolton, professor of psychology.

PHYSIOLOGICAL ECONOMY IN NUTRITION.

IRVING FISHER, professor of political economy at Yale University, has been conducting experiments to discover whether proper mastication and enjoyment of food would produce the 'physiological economy' claimed for it by Mr. Horace Fletcher, and also whether it would lead to the use of low proteid according to the standard advocated by Professor Chittenden. The result of the experiment would seem to answer both these questions in the affirmative. The experiments were conducted with nine Yale students and lasted from January to June, 1906. Careful record of the amounts of food taken, and the constituents in, proteids, fats and carbohydrates, was kept for each man for each day. To avoid weighing at the table, the food was all weighed in the kitchen and served in 'standard portions' of 100 calories each or simple fractions or multiples thereof, so that the men merely needed to record the number of portions eaten. The proportions of proteids, fats and carbohydrates were found by means of the Mechanical Diet Indicator described by Professor Fisher in the *American Journal of Physiology* for April. During the first half of the experiment the men followed two rules only. The first was to thoroughly masticate the food up to a point of 'involuntary swallowing' with the attention, however, upon the taste and enjoyment of the food rather than upon the mere mechanical act of mastication. Any 'counting of chews' was discouraged as was also the forcible holding of food in the mouth, as experience of others, as well as the conclusions of Pawlow, had seemed to show that anything which tended to make eating a bore harmed rather than helped digestion. The second rule was to obey implicitly the leadings of appetite, both in regard to quantity of food and the choice between different foods. In order that this strict obedience to appetite might be the more easily followed, a wide range of choice of foods was supplied and no food was placed before the men which was not specially ordered by them.

This first half of the experiment, therefore, was really an experiment in natural eating, if we may assume that it is unnatural to hurry through our meals and to eat what is set before us, out of politeness, habit or limitation of choice. It was found that, as a consequence of the thorough mastication and obedience to appetite, a profound change occurred in the diet of the men. There was a large reduction in the quantity of liquids of all kinds at meals —water, tea, coffee and even soups. There was a reduction in the total daily average of

calories consumed of about 10 per cent., a reduction of proteids of about 15 per cent., and of flesh foods (meat, fowl, fish and shell fish) of about 40 per cent. During the second half of the experiment the two rules above mentioned were continued in force but a third was added. This was, when the appetite was uncertain in its choice of foods, to give the benefit of the doubt to the low proteid and non-flesh foods and to foods regarded, provisionally, as the most wholesome. This influence of suggestion was never carried however to the point of eating against appetite. This still remained supreme. Suggestion was used merely to settle cases where appetite was not decisive.

During the second half of the experiment there was a still more pronounced change in the character of the diet. Comparing the diet in June with that in January it was found that the total calories had fallen about 25 per cent., proteid about 40 per cent. and the flesh foods over 80 per cent. or to about one sixth of the original amount. Moreover the proteid had fallen to the level indicated as desirable in the previous experiments of Professor Chittenden, which is one and a half calories of proteid per pound of body weight.

Other physiological changes were noted. There was reduction in the quantity of the excretions and in the putrefactive and fermentative properties of the feces.

The body weights of the men during the first half of the experiment fell on an average of two pounds and in the second half fell further four pounds. Gymnasium tests were made to ascertain the strength and endurance of the men. It was found that their strength had remained practically constant through the experiment while their endurance increased during the first half about fifty per cent. and during the second half by as much more. A marked distinction was drawn between strength and endurance, strength being the utmost force which a muscle can exert *once* and endurance the number of times that a muscle can perform an exertion which is within its strength. Seven endurance tests were used: rising on the toes; deep knee bending; leg raising; raising five-pound dumb bells by the triceps; raising successively dumb bells of fifty pounds, twenty-five pounds, ten pounds and five pounds by the biceps; holding the arms horizontal and running. In many of these tests it was found that the will gave out earlier than the muscle; in short, that they were tests of grit, but in others it was found possible to work the muscles up to the point where they refused to contract further. Many precautions were taken to prevent any errors in these comparisons and only those records were used in the final averages in which the men were less tired in January than after the corresponding tests in June or records in which, both in January and June, the muscle was operated up to the point where it refused to contract. Even with all these precautions the improvement in endurance was found to be enormous. For instance, one of the men who in January could not raise a five-pound dumb bell with his triceps beyond the one hundred and eighty-fifth time, in June was able to do so 501 times, and another who could do the leg raising in January 50 times, in June could perform this 105 times; another who in January could lift the twenty-five-pound dumb bells with the biceps 10 times, in June could do so 27 times. The average improvement from January to June, making every possible allowance, was over 90 per cent. The men were not as stiff and sore after the June as after the January tests, in spite of the fact that they had performed double the amount of work.

So far as is known, no other than dietetic causes could have produced this result. The men led sedentary lives with less rather than more exercise than previously. They were no more regular in their habits and made no effort to live more hygienically except in the matter of diet. The dietetic factors were merely a wide range of choice of wholesome foods well cooked and appetizing, slow eating and obedience to appetite. As to which of these factors was the most important, and as to the manner in which physiologically they affected an improvement in endurance, there is much room for speculation. In the light of other facts it may at least be suspected

that one of the chief reasons for improved endurance was a reduction in proteid.

Mental tests were taken consisting of the addition of numbers, these showing slight increase in mental quickness.

A complete account of the experiments will be published shortly. It was undertaken by Professor Fisher in connection with a series of statistics which he is collecting on the subject of labor-power, especially in relation to diet, somewhat similar to the series of statistics collected by the economist Nitti some ten years ago. In communicating to the editor of SCIENCE the foregoing outline of his experiment, he has asked that any readers of SCIENCE who may be able to supply data on this subject from personal experience or other sources will put themselves in correspondence with him.

FIELD WORK OF THE SCIENCE DIVISION OF THE STATE OF NEW YORK.

GEOLOGICAL SURVEY.

Correlation Work.—The director and assistants continued the field investigations necessary to the comparative study of the New York Devonic faunas in their extension eastward. Explorations, resulting in considerable and exhaustive collections, were carried on in northern New Hampshire and Vermont, eastern Maine and in the Gaspé Peninsula, Canada. These field investigations, now completed, have brought to light a very large amount of instructive paleontological and stratigraphical data.

Areal Surveys.—The survey of the crystalline region of the Highlands of the Hudson has been continued. In the Adirondacks, a portion of the iron region of Essex County has been resurveyed and the Theresa quadrangle in Jefferson County well covered. In the area of exclusively sedimentary rocks, surveys have been made in the Lake Champlain Valley, and the following quadrangles in central and western New York have been advanced or brought to completion: Chittenango, Cazenovia, Syracuse, Geneva, Auburn, Nunda, Portage, Skaneateles and Phelps.

Surficial Geology.—Though somewhat interrupted by the absence of the geologists in charge, some advance has been made in the interpretation of the northern Hudson and lower Mohawk Pleistocene phenomena and in the survey of the morainal deposits of western New York.

Paleontology.—A discovery of singular interest is the occurrence of Eurypterus-bearing shales with a novel and extensive fauna in the Shawangunk Mountains of eastern New York. The age of the Shawangunk grit, commonly regarded as equivalent to the Oneida conglomerate (lowest Upper Siluric) of central New York has but recently been demonstrated on purely stratigraphic data, to be the probable equivalent of part or all of the Salina formations. Subsequent to this demonstration the Eurypterus fauna was found in the grit, confirming the stratigraphic deduction, as its species are in some measure those of the Pittsford shale which lies at the base of the Salina series in western New York. The fauna is distributed through nearly 700 feet of the grit deposits. The museum has been enriched by very extensive collections of these fossils. Large acquisitions have also been made from the Eurypterus localities of Herkimer County from the Chazy and Beekmantown limestones of Lake Champlain with some remarkable slabs of Cystideans and other fossils from the Trenton limestone of southern Ontario.

Economic Geology.—A careful reexamination of the iron regions and their ore bodies has been made with the definite purpose of indicating possibilities of future development. These operations have met with a result altogether unanticipated and have determined the presence of undeveloped ore deposits so extensive as to put the state in the first rank of iron-bearing regions of the country. Indeed it is now probable that no equal area contains more available undeveloped iron ore, now to be reckoned by some hundreds of millions of tons of fair to high grade ore representing a vast increase in the potential wealth of New York state.

Other metallic ore industries have also been exploited, an interesting example being the newly developed zinc deposits of St. Lawrence County. Special examination of the sand-

stones of the state have been continued and completed.

Mineralogy.—A discovery of notable interest is the location of a series of vein caverns lined with perfectly developed calcite crystals of extraordinary size. A single crystal of remarkable crystallographic completeness and of a fine amethystine tint weighs nearly 1,000 pounds and innumerable others from 50 to 500 pounds each. In habit these crystals are highly modified rhombohedra with basal pinacoids and scalenohedral faces, frequently twinned but exemplifying a common form without great modification. Probably no such development of calcites so gigantic in size and at the same time so uncomplicated, clear and well built has before been seen in this country. An extensive series of these crystals has been removed for the museum and measures have been taken to control the entire supply for the state's collections.

Caverns.—Careful exploration has been made of the caverns of the Helderberg limestone plateau for the purpose of ascertaining their relations to the existing topography and drainage. It has been possible to determine that this network of underground passages represents successive stages of work not dependent wholly on the joint systems of the region and that, as lines of drainage, these passages are to-day in a decadent stage.

ARCHEOLOGY.

For two years past options have been taken on various lands believed to carry sites of Indian villages or burial grounds, and these are excavated as opportunity affords. This year the archeologist opened a village and burial site near Ripley on the shore of Lake Erie. The encroachment of Lake Erie on this site has been so great as to destroy some part of it, this of itself aside from internal evidence indicating its considerable antiquity. One hundred and fifty graves and refuse pits were opened and from them were obtained an amazing number of all sorts of relics and utensils of this early Erie culture, stone implements and ornaments in great variety, fabrics, skin clothing, seventy pots, about half of which were unbroken, skeletons with ornaments attached and even parts of skin and flesh preserved. No site ever opened in New York has proved so instructive and so prolific in the vestigia of Indian life. The additions thus made to the archeological collections are extensive and important.

BOTANY.

Reexamination of species of Crataegus and the search for additions to fungous flora have been the chief objects of the past field season.

ENTOMOLOGY.

Protective and control measures against the San José scale, the grape root worm, tussock moth and elm leaf beetle and other insect enemies of the fruit and shade trees have been actively carried out. Special investigations upon the Caddis flies and gall midges have also been continued.

INTERCOLLEGIATE GEOLOGICAL EXCURSION.

The annual New England intercollegiate geological excursion was held on Saturday, November 3. This excursion, organized in 1900 by Yale and Harvard, has met at Holyoke, Worcester, Boston, Salem and Meriden, and has annually brought together students from all the New England colleges and many of the normal schools and high schools, participation being limited to teachers of geology and certain advanced students. The expeditions have done much to improve teaching on the subject and to develop friendly relations between the geological departments of the different institutions.

Last Saturday the excursion was conducted at Meriden, Conn., by Professor Gregory, of Yale, and was preceded by a meeting on Friday evening at which the geology of the Meriden region was described. The object of the trip this year was to study the sandstones and interbedded lavas of the Triassic formation, and special attention was given to an important 'fault line,' on which the displacement amounts to 2,000 feet. Professor W. M. Davis, who worked out the structure of the region, pointed out the topographic features which were the result of the faulting; Pro-

fessor W. N. Rice explained the Ash Bed of Lamentation Mountain, and Professor J. Barrell, the two lava flows of the second or main sheet. In addition to advanced students from colleges and teachers from high schools the following institutions were represented: Harvard, Professors Davis and Wolff, Drs. Johnson and Huntington; Massachusetts Institute of Technology, Dr. Loughlin; Wellesley, Professor Fisher; Holyoke, Professor Talbot; Williams, Professor Cleland; Brown, Professor Brown; Wesleyan, Professor Rice; Trinity, Professor Genthe; Rutgers, Professor Lewis; Yale, Professors Gregory, Barrell and Schuchert and Mr. Bowman; U. S. Geological Survey, Dr. George Otis Smith; Salem Normal School, Professor Moore; New Britain Normal School, Professor Loomis. Professor H. F. Cleland, of Williams, was appointed permanent secretary. The next meeting will be held at Providence, Rhode Island, under the leadership of Professors Brown, Emerson and Woodworth.

LOCAL ARRANGEMENTS FOR THE NEW YORK MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND THE AFFILIATED SCIENTIFIC SOCIETIES.

NEW YORK CITY having been selected at the New Orleans meeting of the American Association as the place of the next annual meeting, a notice was published in SCIENCE calling a meeting of local members at Columbia University on January 18. At this meeting plans were discussed and a local executive committee was elected as follows: J. J. Stevenson, chairman, C. C. Adams, Charles Baskerville, Franz Boas, N. L. Britton, H. C. Bumpus, Chas. A. Conant, Simon Flexner, Wm. J. Gies, Wm. Hallock, Alex. C. Humphreys, G. S. Huntington, Edward Kasner, Henry F. Osborn, C. L. Poor, Clifford Richardson, E. B. Wilson, Frederick J. E. Woodbridge, J. McKeen Cattell, secretary. This committee has held four meetings at the American Museum of Natural History. The business transacted and the preliminary arrangements for the meeting may be summarized as follows:

1. The first general session will be held in Earl Hall, Columbia University, at 10 o'clock on the morning of Thursday, December 27. The retiring president, Dr. C. M. Woodward, will introduce the president of the meeting, Dr. W. H. Welch, and President Butler will welcome the members. The usual announcements will then be made. The sections of the association will hold at 11 o'clock their meetings for organization, followed in several cases by the address of the chairman. Council meetings and meetings of organization of the special societies can to advantage be held at 9 o'clock. All the sections of the association and, so far as possible, all the national societies will meet at Columbia University on December 27 at 2 P.M. Several of the sections of the association will hold sessions in which topics of general interest will be discussed. At 8 o'clock the retiring president will give his address in Horace Mann Hall. From 9 to 11 o'clock the trustees of Columbia University will offer a reception. At 10 o'clock there will be an informal smoker in the Faculty Club.

2. On Friday the sections and the societies will hold their regular sessions. It is expected that there will be joint meetings when the same subjects are covered and that some meetings will be arranged of general interest to all members of the association. Friday evening is reserved for dinners and meetings of special societies and groups. It is also suggested that smokers and informal meetings be held on the Wednesday evening preceding the meeting.

3. The meetings will continue on Saturday with some scattering. Thus Section K and the societies devoted to the medical sciences will meet at the Rockefeller Institute, and Section G and the American Botanical Society will meet at the New York Botanical Garden. There will be a lecture at the City College at 12 o'clock, followed by a luncheon and an inspection of the new buildings. At 3:30 o'clock ten marble busts of pioneers of American science, presented by Mr. Morris K. Jesup to the American Museum of Natural

History, will be unveiled. At 8 o'clock there will be a reception by the trustees of the museum and the New York Academy of Sciences with an exhibition of scientific progress by the academy, including demonstrations and short addresses. At 10 o'clock there will be an informal smoker at the Chemists' Club.

4. The meetings will continue on Monday and Tuesday, or so long as is required by the programs, and probably several of the special societies will meet on those days. The meeting of the nominating committee will be on Monday evening.

5. The Hotel Belmont, on 42d street, opposite the Grand Central Station, will be the general headquarters. Adjoining this hotel are the Murray Hill Hotel and the Grand Union Hotel, at which the rates are lower.

SCIENTIFIC NOTES AND NEWS.

A SCIENTIFIC session of the National Academy of Sciences will be held at the Harvard Medical School, Boston, beginning on Tuesday, November 20, at 11 A.M.

THE winter meeting of Section C of the American Association for the Advancement of Science will be held in conjunction with the American Chemical Society at Columbia University, New York, December 27, 1906, to January 2, 1907. The following persons have been appointed to preside over the sections and to aid in the preparations for the meeting:

Physical Chemistry, Alexander Smith.
Inorganic Chemistry, E. H. Miller.
Organic Chemistry, A. S. Wheeler.
Agricultural and Sanitary Chemistry, L. L. Van Slyke.
Biological Chemistry, P. A. Levene.
Industrial Chemistry, A. D. Little.

Members desiring to present papers are requested to send titles and brief abstracts to one of these persons or to the secretary of the section, Professor Charles L. Parsons, New Hampshire College, Durham, N. H. To make sure of consideration, such titles should be received before November 24.

THE American Physiological Society will hold its nineteenth annual meeting during convocation week in New York City, on Thursday, Friday and Saturday, December 27, 28 and 29, 1906. The session on the morning of December 29 will be a joint meeting with Section K—Physiology and Experimental Medicine—of the American Association for the Advancement of Science, at the Rockefeller Institute for Medical Research.

THE annual meetings of the American Anthropological Association and of the American Folk-lore Society will be held in New York City, beginning on December 27, in affiliation with Section H of the American Association for the Advancement of Science.

SIR WILLIAM PERKIN has received the degree of doctor of laws from the Johns Hopkins University, and the degree of doctor of science from Columbia University. He has been entertained by the University of Pennsylvania and other institutions that he has visited.

IN addition to those engineers who were announced in SCIENCE as having been granted the degree of D.Sc. on the occasion of the dedication of the new engineering building of the University of Pennsylvania, the degree was conferred on Professor W. P. Blake. In presenting Professor Blake for the degree, Mr. Arthur L. Chase said: "We ask you to confer the degree on William Phipps Blake, because of his knowledge and experience in mining engineering, geology and mineralogy. The results of his activities have been useful to the governments of the United States, to Japan, to the state of California and to Arizona territory. For many years he has occupied a distinguished position as a teacher, and he has written a great number of illuminating books and papers on the mining of the precious metals and other technical subjects."

CAPTAIN ROALD AMUNDSEN sailed on November 8, on the Scandinavian-American steamer *Hellig Olav*, for Christiania, where the records of his magnetic observations in the Arctic will be worked out. Captain Amundsen has presented his entire collection to the Norwegian government. The new king of Norway has conferred upon him the highest decoration of the kingdom, the grand cross and cordon of St. Olaf.

ON the evening of November 3 the Geographic Society of Chicago tendered a reception and banquet to Captain Roald Amundsen on the occasion of his return from three and one half years of successful exploration in the region of the magnetic north pole. Addresses were made by the guest of honor, and by his first officer, Lieutenant Hansen; by the Norwegian consul, Fredrik Herman Gade; by the president of the society, Professor Henry J. Cox, and by Professors R. D. Salisbury and T. C. Chamberlin, of the University of Chicago.

PROFESSOR ROLAND THAXTER, of Harvard University, has returned from a year's leave of absence, a portion of which was spent in South America, and has brought back considerable collections of various cryptogams, most of which were obtained on the Straits of Magellan.

PROFESSOR WALTHER NERNST, of the University of Berlin, has returned to Germany after delivering the Silliman lectures at Yale University.

DR. SVEN HEDIN, who by order of the government was denied access to Tibet from the side of India, is making good his entry into western Tibet from Chinese Turkestan.

MR. WALTER WELLMAN and Major Hersey have sailed for New York on the French steamer *La Savoie*. The former will return to Paris in six weeks to continue his supervision of the changes in his airship. Major Hersey will accompany the Chicago *Record-Herald* expedition in its attempt to reach the Pole next summer.

RICHARD M. SHAW, a student in the medical department of the University of Pennsylvania, has joined an expedition organized by Dr. W. G. Miller, of Philadelphia, for the purpose of making explorations in Alabama and Florida. About two months will be spent in Alabama, during which a number of Indian burial mounds will be excavated, and four months will be spent in making similar investigations in Florida.

DR. HENRY S. PRITCHETT, of the Carnegie Foundation, will be the principal speaker at the thirty-fifth anniversary exercises at the Johns Hopkins University on February 22.

MR. H. YULE OLDHAM, reader in geography at Cambridge University, is giving a course of public lectures this term on 'The History of Geographical Discovery,' dealing principally with the discovery of America.

AT the annual general meeting of the British Astronomical Association Mr. F. W. Lavender was elected president to succeed Mr. A. C. D. Crommelin. Other officers were elected as follows: A. C. D. Crommelin, E. W. Maunder, S. A. Saunder and W. H. Wesley as vice-presidents, Mr. W. H. Maw as treasurer and Messrs. J. G. Petrie and J. A. Hardcastle as secretaries.

DR. R. HERTWIG, professor of zoology and comparative anatomy at Munich, has celebrated the twenty-fifth anniversary of his professorship.

DR. FRANZ MERTENS, professor of mathematics at Vienna, has received a prize of the value of 5,000 Marks, given every third year by the Berlin Academy of Sciences for the most important mathematical work.

DR. VON ELSNER has been appointed associate in the Meteorological Observatory at Berlin.

MR. N. R. GRAHAM, of the chemical department of the College of the City of New York, has secured a patent on a typewriter attachment which facilitates the writing of chemical formulas.

The government of India has granted Mr. A. R. Brown, Anthony Wilkin student in ethnology and archeology at Cambridge University, a sum of £300 to assist him in carrying on his researches amongst the natives of the Andaman and Nicobar Islands.

As the result of correspondence between Mr. Cornelius Vanderbilt, president of the Robert Fulton Monument Association, and the four surviving direct descendants of the inventor of the steamboat, these descendants have consented to the removal of the remains of Fulton from Trinity churchyard to the tomb and monument that the association is planning to erect.

Dr. Edmund Howd Miller, professor of analytical chemistry at Columbia University, died on November 8, at the age of thirty-eight years. Dr. Miller received his bachelor's, master's and doctor's degrees from Columbia University, and was promoted to be assistant, tutor, instructor, adjunct professor and professor at that institution. He was a fellow of the American Association for the Advancement of Science and has been chairman of the New York Section of the American Chemical Society. He had carried out researches on fire-assay methods, including assays of tin, platinum, etc.

The death is announced of Dr. Ernst Caesaro, professor of mathematics at Naples.

Civil service examinations are announced as follows: On November 30, for the position of laboratory assistant qualified in practical optics in the Bureau of Standards at a salary of $1,000; on December 5, for the position of aid in the Coast and Geodetic Survey, at a salary of $720; for the position of preparator of fossils in the Geological Survey, at $75 a month; for the position of psychologist in the Government Asylum for the Insane, at a salary of $1,500, and for the position of arboriculturist in the Bureau of Plant Industry, at a salary of $2,000.

The University of California has received by donation the herbarium and botanical library of Mr. and Mrs. T. S. Brandegee, of San Diego. The herbarium is one of the most important in the west, since it contains something over 100,000 sheets of carefully selected plants, mostly representative of the Mexican flora, which for many years has been Mr. Brandegee's chosen field, and of the flora of California and neighboring states, which has received careful treatment at the hands of Mrs. Brandegee. It contains the sole remaining duplicate types of many species, the originals of which were lost in the recent fire that destroyed so large a portion of the California Academy of Sciences herbarium, as well as the types of practically all the new species described by Mr. and Mrs. Brandegee themselves. Among the noteworthy sets represented are Bebb's Willows, Parry's Manzanitas and Chorizanthes, a majority of the Mexican sets distributed by Palmer, Pringle, Lumholtz, Purpus, etc., and a selection of types and duplicate types from the Orcutt and Cleveland herbaria. It is probable that no other herbarium contains so nearly complete a representation of the North American Borraginaceæ. It is also rich in Mimulus, Eriogonum and other groups in which Mrs. Brandegee has been particularly interested. The university herbarium, as now enlarged, numbers approximately 250,000 sheets, a majority of which are mounted in permanent form. The whole collection is available for study and occupies fire-proof quarters in one of the buildings recently erected on the university campus. Here visiting botanists desiring to study the west American and Mexican flora or to consult the working library of the herbarium, will be welcome and given every opportunity for research work. Mr. and Mrs. Brandegee will continue their studies at the university, where Mr. Brandegee has been appointed honorary curator of the herbarium. Mail matter may hereafter be addressed to them at the university.

The Academy of Natural Sciences of Philadelphia has recently acquired two notable zoological collections. One of these is the Gulick collection of Hawaiian land shells, which served as the basis of Rev. John T. Gulick's well-known work, 'Evolution: Racial and Habitudinal.' It contains elaborate series representing the numerous geographic and local races, not a few of which are to-day quite extinct. The other accession is the Tristram collection of birds numbering some 7,000 skins and representing upwards of 3,000 species. This is the second collection made by the late Canon Tristram, the first one having been secured some years ago by the Liverpool Museum. The present collection comprises birds from all parts of the world, but is especially rich in insular forms and in northern South American birds. Several other collections obtained by the academy during the last few years—notably the Sumatran collection, obtained and presented by Mr. A. C. Harrison, Jr., and Dr. H. M. Hiller; the

collection from British East Africa deposited by Mr. Geo. L. Harrison, Jr., and the Porter Philippine collection—have greatly increased the value of the ornithological department of the museum and the Tristram collection brings the total number of specimens up to nearly sixty thousand.

THROUGH the generous gift of Mrs. Russell, the library of the late Professor Israel C. Russell has become the property of the University of Michigan; and by her request it will be kept separate to form the nucleus of a Departmental Library of Geology. The regents of the university in accepting the gift authorized changes in the museum building—at present the home of the geological department —and in a few weeks the books will be arranged upon shelves in a new geological seminary room to be known as the 'Israel C. Russell Room' and prepared as a memorial to this distinguished geologist. The collection which thus comes into the possession of the University of Michigan is especially rich in the separate publications of geologists; and these, like the reports and bound volumes of the collection, are to be entered in the main library catalogue of the university. An appeal will be made to working geologists here and abroad in the hope that they will place upon their exchange lists in place of Professor Russell's name the name 'Russell Library,' continuing the old address, University of Michigan, Ann Arbor, Mich., U. S. A. Contributions to the collection will be acknowledged by the university librarian, promptly entered in the catalogue, and sent to the Russell Room, where they will at once be accessible to all students of geology. A similar request will be made of the directors of geological surveys and of other geological institutions, in order that the very valuable series of their publications may be kept complete. It is thought that means will be found to continue the subscription on behalf of the library to the important geological and geographic journals which were regularly taken by Professor Russell. Printed address slips for mailing or expressing publications will be supplied upon application either to the university librarian or to Professor W. H. Hobbs, in care of the university. If notified in advance, the library will generally be willing to pay the charges upon express packages. A considerable number of separate copies of several of Professor Russell's shorter papers are still available for distribution. If geologists will indicate what papers they already possess, the attempt will be made to supply the deficiencies as far as is possible.

AT a cabinet meeting held in Paris on October 30 a measure was approved providing for the abolition of the death penalty.

THE library of the late Dr. Willard Parker, containing 4,000 volumes, was formally presented to the Medical Society of the County of Kings, October 16. The presentation was made by Dr. Willard Parker, his son, who will be made an honorary member of the society.

THE Central Committee for Scientific Research on the Brain, appointed by the International Association of Academies, has recognized the Senckenberg Neurological Institute, Frankfort on the Main, as an international institute for the purpose.

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BY the will of Mr. John Daglish, Armstrong College, Durham, will ultimately receive a bequest of £30,000 and the residue of the estate.

AT the University of Nebraska the wing of the new museum building is approaching completion. It is four stories high and is fireproof throughout. The 'Temple,' intended for the use of the various societies of the university, is well under way. It occupies a quarter of a city block, being nearly 140 feet square, and is to have four stories. It is built of white sandstone and bronze brick.

NEW buildings for a mining and metallurgical department at the University of Leeds are about to be erected. Plans have been approved and tenders invited; and it is expected that the new buildings will be ready by next session. The capital fund raised for building and endowment purposes as part of the £100,000 required by the Privy Council now amounts to some £75,000.

THE old Harvard Medical School, which has the assessed valuation of $596,000, has recently been sold by the university. The building will be demolished and an office building will be erected in its place.

THE eighth annual conference of the Association of American Universities will be held in Phillips Brooks House, Harvard University, on November 23 and 24. The following universities are members of the association: California, Catholic, Chicago, Clark, Columbia, Cornell, Harvard, Johns Hopkins, Leland Stanford, Jr., Michigan, Pennsylvania, Princeton, Virginia, Wisconsin and Yale.

THE fiftieth annual meeting of the Association of Colleges in New England was held in New Haven on Monday and on Tuesday, October 29 and 30. The subjects proposed for discussion at this meeting were:

Taxation of colleges, and the means of common action thereon by college authorities. (Suggested by Harvard.)

The relation of work for the degree of A.M. to the case of students whose work for the A.B. is slightly deficient. (Harvard.)

What should determine the amount and arrangement of college charges for tuition? (Yale.)

The correlation and cooperation of the departments of instruction in a college. (Brown.)

How can we prevent illiteracy in college graduates? (Brown.)

The honor system in examinations. (Williams.)

Religious organizations: their place in our colleges and universities. (Williams.)

Is hazing a thing to regulate or extirpate? (Amherst.)

What share, under existing conditions, should be allotted to the faculty in the government of a New England college? (Amherst.)

What should be the qualifications of a candidate for a special course in college? (Wesleyan.)

Is it advisable to offer a course in college to beginners in Greek? (Wesleyan.)

The abolition of material diminution of required mathematics in college, except for scientific students. (Wesleyan.)

How far can the responsibility be put upon the student body for the conduct and deportment of students. (Wesleyan.)

MR. FREDERICK A. GOETZE, superintendent of buildings and grounds at Columbia University, has been appointed dean of the faculty of applied science.

IN the department of biology, Purdue University, new appointments are announced as follows: Howard E. Enders, Ph.D. (Johns Hopkins), to be instructor in zoology; Oliver P. Terry, M.D. (Purdue, '02), to be instructor in physiology and anatomy.

WORK in sanitary and experimental biology has been introduced at Williams College under Lorande Loss Woodruff, Ph.D. (Columbia).

DR. T. C. STEPHENS, recent fellow in zoology, University of Chicago, has been elected professor of biology at Morningside College, Sioux City, Iowa.

THE following appointments have been made in the scientific departments of George Washington University: Professor of botany, Albert Mann, B.A. (Wesleyan), Ph.D. (Munich) formerly professor of botany in Ohio Wesleyan University and expert in the Department of Agriculture; assistant professor of mathematics, Paul Noble Peck, A.B. and A.M. (George Washington), promoted from an instructorship; instructor in chemistry, Walter Otheman Snelling, B.S. (George Washington), B.S. (Harvard), M.S. (Yale), 1906; instructor in mathematics, George Albert Ross, A.B. (William Jewell), A.M. (George Washington); instructor in civil engineering, Oscar A. Mechlin, B.A. (Dartmouth), C.E. (George Washington), assistant engineer, District of Columbia; instructor in mechanical engineering, A. C. Willard, B.S. (Mass. Inst.), principal, University School, San Francisco; instructor in physics and electricity, Everett W. Varney, A.B. (Bowdoin), assistant of physics, Bowdoin College; instructor in electrical engineering, T. F. S. Maguire, B.S. (Mass. Inst.); professor of nervous diseases, Charles H. Clark, M.D. (Starling Medical College), clinical director of the Government Hospital for the Insane; professor of physiology, Shepherd Ivory Franz, A.B. and Ph.D. (Columbia), pathological physiologist at the McLean Hospital, Waverly, Mass.